U.S. Army Research Institute
for the Behavioral and Social Sciences

Research Report 1540

Summary of Research on Combat Vehicle Identification Completed at ARI Fort Hood Field Unit, Fort Hood, Texas, 1980-1985

William L. Warnick
Essex Corp.

Norman D. Smith
U.S. Army Research Institute

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EDGAR M. JOHNSON
Technical Director

JON W. BLADES
COL, IN
Commanding

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Essex Corp.

Technical review by

Harold Fritz (C/J-3 Plans Combined Forces, Korea)
Carol A. Johnson (ARI)
Cliff Linstrom (CATA-CTI, Ft. Leavenworth, KS)
Donald S. Peckham (TRADOC)

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This historical review was prepared to provide the Army proponent for vehicle recognition, the U.S. Army Combined Arms Center (CAC), with a summary of research and development products emanating from the Army's "Target Acquisition and Analysis Training System (TAATS)" during the period 1980 to 1985. The report was prepared by the Fort Hood Field Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences.

Sixty research projects (including 15 ARI-conducted TAATS efforts) that contributed to the TAATS research effort are summarized in this report. The summaries are extensive in that both the research methodology and the major research conclusions are presented and well documented.

The Commander, U.S. Army Training and Doctrine Command (TRADOC), in 1979 centralized the proponency for vehicle recognition within the Combined Arms Center (CAC) at Fort Leavenworth, Kansas. This action focused attention on the need for an effective and uniform

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22a. NAME OF RESPONSIBLE INDIVIDUAL
Charles O. Nystrom

22b. TELEPHONE *(Include Area Code)*
(817) 288-9222

22c. OFFICE SYMBOL
PERI-SH

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combat vehicle recognition and identification program as a total Army requirement. In coordination with CAC, the ARI Field Unit at Fort Hood initiated the TAATS research program in 1980.

The research resulted in the development of three Combat Vehicle Identification (CVI) instructional programs being added to the Government Training Aid (GTA) system, i.e., GTA 17-2-9, GTA 17-2-10, and GTA 17-2-11. Two video training films were developed for integration into TRADOC branch school curriculums.

The major conclusions having the greatest impact on training and doctrine development are:

- The quality of a combat vehicle's image is not a critical factor in identifying the vehicle or in learning identification skills provided gross cues (e.g., chassis shape, turret shape and position, relative length of gun tube) are discriminable.

- The use of motion in depicting a vehicle is not critical in training soldiers in CVI.

- Training all combat soldiers in CVI skills may not be cost-effective. Approximately one-third of soldiers after four training trials failed to achieve the level of CVI proficiency reached by the other two-thirds after one learning trial.

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William L. Warnick
Essex Corp.

Norman D. Smith
U.S. Army Research Institute

ARI Field Unit at Fort Hood, Texas
George M. Gividen, Jr., Chief

Systems Research Laboratory
Robin L. Keesee, Director

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

Office, Deputy Chief of Staff for Personnel
Department of the Army

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Training and Simulation

FOREWORD

This document presents a review of the research and research products that emanated from the Target Acquisition and Analysis Training System (TAATS) effort, a work unit established at the Fort Hood Field Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences. The major goal of TAATS was to provide a framework within which both system and training issues related to target acquisition could be addressed. Such a framework fostered the development of a body of knowledge and a team of researchers who systematically addressed the many factors related to this area. Although target acquisition and analysis embody a wide range of tasks, the priority of immediate Army needs dictated that one task, target identification, receive major attention during the life of the work unit. This task will continue to be critical for the operator of any weapon, whether a rifle, a tank main gun, or an air defense weapon. This document is intended to assist those who must continue to address research related to target acquisition and analysis.

From 1980 to 1985 the TAATS project produced more than 15 research reports on issues related to improved soldier performance in target identification. Topics included were effects of motion on performance; effects of number of vehicles trained, training frequency, and soldier trainability; retention and the effects of retraining; cue recognition; training readiness and GT score as correlates of performance; and improving performance using thermal imagery. Training program that were developed and added to the Government Training Aids (GTA) inventory were The Basic Combat Vehicle Identification (CVI) Training Program (GTA 17-2-9), The Thermal Combat Vehicle Identification (TCVI) Training Program (GTA 17-2-10), and The Combat Vehicle Identification Flash Cards (GTA 17-2-11). Video training programs developed and turned over to the proponent for vehicle identification, Fort Leavenworth, Kansas, were Tank Thermal Sight Adjustment Training Program and Training for Combat.

The proponent for this research was the U.S. Army Combined Arms Center (CAC), Fort Leavenworth, Kansas. The results of this effort have been briefed to the Commanding General, Training and Doctrine Command (TRADOC), Commanding General, U.S. Army Forces Command (FORSCOM), and selected general officers and staff officers of TRADOC, FORSCOM, and U.S. Army Europe (USAREUR), the U.S. Marine Corps, and the U.S. Air Force.

Edgar M. Johnson

EDGAR M. JOHNSON
Technical Director

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Those officers who served as Army proponents at the Combined Arms Center, Fort Leavenworth, Kansas, during this time deserve special mention. They were John Blankenship and Hal Fritz.

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SUMMARY OF RESEARCH ON COMBAT VEHICLE IDENTIFICATION COMPLETED AT ARI FORT HOOD FIELD UNIT, FORT HOOD, TEXAS, 1980-1985

EXECUTIVE SUMMARY

Requirement:

A decision in 1980 by the Commander, the U.S. Army Combined Arms Center (CAC), Ft. Leavenworth, Kansas, established CAC as the proponent for vehicle recognition training. The rationale for the action was that vehicle recognition training was a concern of the entire Army and locating the proponency at CAC would ensure that all branches would be included in the training. The concentration of doctrinal oversight at Ft. Leavenworth and research and development at Ft. Hood provided the necessary framework within which the "Target Acquisition and Analysis Training Systems (TAATS)" work unit could operate effectively.

The purpose of this report is to provide the proponent with a summary of the research and development efforts that emanated from the TAATS work unit from 1980 through 1985.

Procedure:

Sixty research projects are summarized that contributed to or were a direct result of the TAATS work unit. The report presents more extensive explication of the TAATS research and its products than is usually found in a review of the literature. This was done to give the reader sufficient information about the research to better evaluate the findings and conclusions without the requirement of locating and reading the original research report. It is anticipated that this will make the document more useful as a single resource for information on vehicle identification research.

Findings:

Major research findings having an impact on training development are

- The quality of a combat vehicle image is not a critical factor in teaching identification skills provided that the important cues (chassis shape and size, turret shape and position, and at times the gun tube) are discriminable in the image.

- Use of motion in depicting a vehicle is not critical in training vehicle identification.

- Training all combat soldiers in vehicle identification skills may not be cost-effective; about one third of the soldiers after four training trials failed to meet minimum expectations.

- Soldiers who score "high" or "low" in vehicle identification performance can be identified in advance 77% of the time by using quadratic discriminate functions involving ASVAB Scaled Scores.

- Three developmental training products were added to the Government Training Aid (GTA) system, e.g., GTAs 17-2-9, 10, and 11, and two video training films were incorporated into the Training and Doctrine Command school system.

Utilization of Findings:

Weapons systems, both old and new, continue to face the requirement of improving the capability of the man in the target acquisition and analysis process. This document will serve as a resource to the proponent for vehicle recognition and others who have the task of continuing to look for solutions in this challenging area.

SUMMARY OF RESEARCH ON COMBAT VEHICLE IDENTIFICATION COMPLETED AT ARI FORT HOOD FIELD UNIT, FORT HOOD, TEXAS, 1980-1985.

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SUMMARY OF RESEARCH ON COMBAT VEHICLE IDENTIFICATION COMPLETED AT ARI FORT HOOD FIELD UNIT, FORT HOOD, TEXAS, 1980-1985

Chapter 1

VEHICLE IDENTIFICATION RESEARCH, 1975-1980

General Background

As weapons systems improve and longer range engagements become possible, there is a growing awareness within the Army of the importance of soldiers being able to recognize and identify targets at extended ranges. Indications of this need were evidenced in requests to the U.S. Army Research Institute dating back to 1975 from both Forces Command (FORSCOM) and the Training and Doctrine Command (TRADOC) for research related to Target Acquisition. In 1980, in collaboration with the Army's proponent for vehicle recognition at the Combined Arms Center, Fort Leavenworth, Kansas, ARI and its support contractors, HumRRO, and later Essex Corporation, developed a coherent and responsive program titled "Target Acquisition and Analysis Training System (TAATS)." The underlying concept for the TAATS research effort has been to provide a logical framework within which to examine training problems and develop training solutions for the Army in the Target Acquisition area.

Based on a review of the literature done in 1975-76 by Maxey, et al. (1976),[1] a conceptual model of the target acquisition process was developed (Table 1). This model was to serve as the basis for a systematic plan of research into target acquisition. The research was intended to address all aspects of the model for the Target Acquisition process, but due to the priority placed on the area of recognition and identification, the work cited in the report concentrated on research and training program developments in Area III (Target Determination).

Table 1.

Target Acquisition Process Model

I. Surveillance and Search
II. Detection
III. Target Determination
 a. Classification (Type: truck, tank, track, etc.)
 b. Recognition (Friend/Threat)
 c. Identification (Vehicle name or number)
IV. Target Engagement
 a. Primary Fire Commands
 b. Subsequent Fire Commands
V. Acquisition of a New Target

Preliminary Research for TAATS (1975-1980)

The research from 1975 to 1980 provided the background data and findings upon which the later TAATS research program was based.

The review of pertinent literature done in 1975-76 by Maxey, et al. identified factors which influence the target acquisition process and examined the effects of these factors on the target acquisition process in a ground environment. A review of over 300 documents was conducted to identify the behavioral, environmental, and situational variables which affect the ability of human observers to perform visual acquisition tasks in field situations. The review identified 24 variables which are likely to affect the visual acquisition process for ground-to-ground target situations (See Table 2). Of the 24 variables, eight were target; seven environmental; five task characteristics; and five were observer variables. The primary threat targets to be encountered were: tanks, mechanized infantry and artillery, and tracked air defense weapons. The literature also suggested that threat forces antiarmor weapons systems were designed to form an interlocking defense system effective over ranges from 0 to 3500 meters. As further preparation for this research, an analysis of relevant "threat" materials was conducted in an attempt to identify the type of targets and tactics the Army would be most likely to encounter in a European battlefield environment.

Table 2.

Behavioral Variables Affecting Ground-to-Ground Visual Target Acquisition

	STIMULUS VARIABLES	
Target	Environmental	Task
Size	Atmosphere	Observer Movements
Shape	Ambient Illumination	Size of Search Area
Color Contrast	Terrain	Practice
Brightness Contrast	Vegetation	Search Strategy
Range	Target Location	Duration of Observation
Duration of the Exposure	Illuminate Position	
Presence of the Motion	Ambient Temperature	
Speed		
	OBSERVER VARIABLES	
Visual Acuity		Past Experience and Training
Observer Height		Motivation

Coinciding with the conclusion of the literature review, the 6th U.S. Cavalry Brigade (Air Combat) submitted a request to the U.S. Army Research Institute, Fort Hood Field Unit, for research in long range target identification for attack helicopter crewmen. The support contractor, the Human Resources Research Organization (HumRRO), was given the task. To counter the development of threat antitank missiles which are accurate and lethal out to 3000 meters and sophisticated air defense systems in the forward areas of battle zones, U.S. Air Cavalry attack helicopters were to be equipped with the extended range TOW weapons system. The objective was to be able to fire at standoff ranges using nap-of-the-earth (NOE) tactics. Using this tactic would make U.S. attack helicopters far less vulnerable to threat air defense systems than they would be at the ranges required for engaging with 2.75mm rockets or conventional tube-type weapons. One of the potential problems with these tactics was the ability of air crews to be able to identify targets at extended ranges. At standoff ranges both friendly and threat armored vehicles present very small visual images, when viewed by the unaided eye. The visual angle could range between one and five minutes, depending on the target size and range. Even with optical aids (such as 7x50 binoculars or the 13 power TOW gunsight), these images are still so small that only gross target features are clearly recognizable. A further complicating factor is that many friendly and threat armored vehicles are very similar in terms of shape, overall physical dimensions, and locations of external items (e.g., machineguns).

The Research Problem

The initial research problem was to determine whether armored vehicles could be reliably recognized and identified at extended ranges with the 13 power TOW gunsight. As a corollary to this problem, questions were raised about the effectiveness of the Brigade's current training in recognition and identification (R&I). The literature review by Maxey, et al. (1976)[2] provided the basis for a series of research projects with long range recognition and identification as the focus. Two fundamental research questions were addressed:

- Could helicopter crew members who had received previous training in armored vehicle identification actually recognize and identify armored vehicles at extended ranges (3000-4000 meters)?

- Could helicopter crew members be trained to identify armored vehicles at extended ranges to 95% level of accuracy?

The research used 1:87 scale models and a terrain board for the following reasons: (a) reduced cost, (b) many of the vehicles needed in the target array were not available in full scale, and (c) experimental control was easier to maintain.

Two experiments were designed and carried out by Haverland and Maxey (1978).[3] The first was a preliminary experiment and the second was a larger experiment designed on the basis of lessons learned from the preliminary experiment. The observers in both experiments used optical aids, binoculars (7x50) in the first, and the 13 power gunsight on the Cobra helicopter in the second (main experiment). In both experiments, observers viewed five views (side left, side right, oblique left, oblique right and front) of five models of armored vehicles (1:87) which were painted olive drab and placed against a homogeneous green textured background. One group viewed the vehicles at a simulated range of 3000 meters and the other group viewed them at a simulated range of 4000 meters. Each observer was asked to make two responses. The first was a recognition response. Recognition was defined as the ability to determine whether the vehicle was a friendly or threat vehicle. The second response was an identification response. Identification was defined as stating the correct vehicle alphanumeric designation or its most common name. Training was discontinued after a participant correctly recognized and identified one complete series of all vehicles in the array (twenty-five target presentations).

The principal findings were:

- There were no statistically significant differences in a final test of R&I performance at simulated ranges of 3000 and 4000 meters. Mean identification accuracy for personnel at both ranges exceeded 95 percent.

- Target aspect angle was the only factor significantly related to R&I performance. (Of the five aspect angles, the front view, the most difficult, was statistically significant from all other views. The side and oblique views were easier and not significantly different from each other.)

- Pretraining identification scores ranged from 48 to 77 percent, and after training the observers were able to recognize and identify to a level of 98 percent.

- A significantly greater number of target presentations was needed to reach criterion in the training phase of the main experiment for observers at the 4000 meter simulated range than for observers at the 3000 meter simulated range.

In the Haverland and Maxey research discussed above, camouflage patterns were not used. The use of pattern painting (camouflage) had recently been adopted by the U.S. forces and almost every nation, friendly and threat, now use some type of pattern painting to camouflage their vehicles. It was decided that a logical extension of Haverland and Maxey's work would be a replication employing camouflaged vehicles. It was felt that a comparison of Haverland and Maxey's results with those obtained with pattern painted vehicles would yield information on the unique contribution of pattern painting as it affected recognition and identification performance.

Warnick, Chastain, and Ton (1979)[4] conducted two experiments. The first was a replication of the Haverland and Maxey main experiment (described above) in which pattern painted vehicles were placed on a homogeneous green textured background. The second experiment by Warnick, et al. used pattern painted vehicles viewed against a simulated terrain background. In experiment one, observers viewed the pattern painted vehicles (five-vehicle target array) at scaled ranges of 3000 and 4000 meters against the same homogeneous green textured background used in the Haverland and Maxey experiments. The majority of the results substantiated the findings of Haverland and Maxey.

The major findings of the first experiment were:

- Pattern painting camouflage did not interfere with R&I when presented against a homogeneous background at scaled ranges of 3000 and 4000 meters.

- R&I performance scores of nearly 98% were obtained using a five-vehicle target array following 20-25 minutes of training.

The second experiment was designed to study more intensive degradation of viewing conditions in order to place the problem of R&I into an environment more closely resembling the "real world." An HO scale terrain board was specially built for the experiment. The target array was increased to 10 pattern painted camouflaged armor vehicles. Targets were viewed at scaled ranges of 2500 and 3500 meters using 13 power optics. The maximum viewing range, even with the 13 power optics, was reduced to 3500 meters, rather than 4000 meters, as used in the previous experiments. Preliminary research indicated that the camouflaged vehicles started to blend with the multi-colored, highly textured terrain model at ranges beyond 3500 meters.

Major results of the second experiment were as follows:

- No significant differences emerged in performance at the two ranges (2500 and 3500 meters). Mean percent identified for 2500 meters was 96.1% and for 3500 was 88.8%.

- Increasing the target number from 5 vehicles to 10 vehicles increased the task difficulty when posttraining identification scores were compared (99% for five vehicles vs. 89% for ten vehicles). Comparison of mean pretest identification accuracy of 47% with mean posttraining identification accuracy was 79%.

- Performance tended to stabilize after 60 training presentations. Little additional learning appeared to take place after each vehicle was shown six times (60 total presentations).

The second fundamental issue raised by the 6th Air Cavalry Brigade was a concern about the adequacy of the current training methods used for training vehicle identification. A preliminary review of existing programs indicated that, generally, these programs concentrated on teaching the recognition of features that can be used to distinguish among various armored vehicles, irrespective of the visibility of such features at different ranges. In fact, the results of the earlier ARI research (Haverland and Maxey, 1978)[5] indicated that many targets were incorrectly named because the presence of a specific recognition feature could not be discerned. It was apparent that there was a need for valid information concerning the distances at which the recognition and identification features of armored vehicles can be detected under a wide variety of viewing and environmental factors. As an initial step, Foskett, Baldwin, and Kubala (1978)[6] conducted a limited experiment to determine the ranges at which various potentially useful features become visually available under optimum conditions. This research effort was intended to establish the outer limits at which particular features could be detected under relatively optimum conditions. Twenty HO scale model armored vehicles were selected for the test. The models were displayed in a lighted display box. Each observer walked toward the display box along a masking tape line. The tape was marked in 100 meter increments based on the 1:87 scale of the models. Some of the major findings were:

- A number of potential recognition and identification features stressed in current training programs were not seen until the observer was very close to the target (e.g., number of roadwheels, gun tubes, sprocket locations).

- The only features seen at scaled distances greater than 1200 meters were (a) tracked vs. wheeled, (b) presence of a turret, and (c) turret location.

The results clearly indicated that there was less need to stress crewmen knowledge of a feature on a vehicle which cannot be discerned, for example, at ranges over 500 meters when their weapons system was designed to engage at ranges beyond 1000 meters. It was concluded that the major emphasis should be placed on teaching those specific features most useful to the individual soldier in his particular circumstances. Logically, the greatest effort should be placed on training a crewman to identify vehicles at or just beyond the maximum effective range of his weapon, thereby optimizing his engagement possibilities.

It was obvious that the research to date with aviators from the 6th ACCB had showed that armored vehicles could be recognized and identified at tactical ranges, if training programs embodied the conditions employed during the research. On the other hand, the poor pretest performance indicated that R&I training being used in the 6th ACCB had not fully prepared them for the task of identification. Several reasons became apparent during the course of the research. For example, through discussions with the aviators it became obvious that they were looking for cues that simply were not visible at longer ranges. Many also were looking for cues that might not always be present. For example, several pilots stated that they failed to correctly identify the M60 tank, as it had no searchlight. While most M60 tanks do carry a searchlight, it is removable and could easily be stowed or destroyed during battle. The searchlight had been removed from the model; therefore, it is not a dependable feature on which to base identification. The inability to identify the M60 tank was somewhat surprising as the air crew personnel saw this particular vehicle almost daily. The failure pointed out the need for air crew personnel to learn vehicle identification on the basis of stable characteristics. Several observers attempted to use the position of the bore evacuators as a cue for identification when a vehicle was viewed from the side. The bore evacuator is virtually impossible to see at the extended ranges employed. When observers could not see or locate identifying features they had learned, they experienced difficulty in identifying the vehicle.

These kinds of observations led the research team to make further inquiries about Army training in vehicle identification. It was discovered that the Army had no standard training program on the subject, although several kinds of materials were available. Units desiring to train their personnel in vehicle identification were required to develop their own programs employing whatever materials they felt met their needs. A few such programs were examined by the research team. Several kinds of deficiencies were noted:

- Soldiers were typically taught to identify vehicles from highly detailed drawings or from photographs taken at very close ranges. Identifying features and characteristics learned and most often stressed during training were those which could be seen only at close ranges. Many of these cues are of little or no value at tactical ranges. This tendency to learn and try to use the easy cues has been called "overshadowing." Cockrell (1978)[7] invoked this concept to explain the results of his identification research. He found that soldiers who had access to the most cues in training performed more poorly in a test situation where cues were reduced than did soldiers who were trained in the reduced cue situation. Cockrell even suggests that training on the most obvious cues may be counterproductive if targets are typically seen under degraded viewing conditions in the field.

- The identification of threat vehicles was typically emphasized in training programs. As a result, the identifying characteristics of friendly vehicles were less likely to be learned. This could easily result in a delay in identification, as a soldier would have to ensure that an "unknown" was not a threat vehicle, rather than recognizing it immediately as a friend.

- The imagery employed (slides, photographs) often permitted a soldier to identify a vehicle on the basis of irrelevant characteristics of the image. For example, an unusual building or object(s) in the background might distinguish a particular photograph from all others. The research team labeled this behavior the "lazy mind syndrome" It is not known how frequently this type of learning happens or has happened in combat vehicle identification training, although several authorities have mentioned this as a problem. It is known to have occurred with an aircraft identification training program. This was observed by Kubala (1965)[8] during the course of research on aircraft identification at Fort Bliss, Texas. Trainees learned to identify a particular aircraft on the basis of a plowed field which appeared in one corner of the photograph which was observed to resemble corduroy. Cockrell also pointed out the need "to insure that no background cues or other extraneous cues are correlated with one of the vehicles and not with the others." Small shape or color variations in the camouflage pattern also acted as cues to identification even though the soldier could not identify the vehicle by its shape characteristics. In learning identification skills the human mind tries to find the easiest way to learn. For this reason, in the development of the training program for the research with the 6th ACCB, the background was held constant for all vehicles and all vehicles were pattern painted in approximately the same pattern. This forced the soldier to focus on each vehicles's identification features and characteristics.

Concurrently with the work on long range target recognition and identification, Ton and Kubala (1979)[9] were conducting research to develop efficient target handoff techniques for aircrews. A simulation employing static imagery was developed. In the simulation, one aviator played the role of an observation helicopter (OH) crewman and one played the role of an attack helicopter (AH) crewman. Each viewed the same scene, but from a different perspective and range. The pilot playing the OH crewman was shown the designated target, and his job was to hand off the target to the AH crewman through oral communications. The target in some situations was only partially visible to the AH crewman. Once the AH crewman believed that he had acquired the target, he was required to make a positive identification.

During the conduct of the handoff research, it was discovered that the majority of pilots were unable to positively identify many of the potential targets, often mistaking a friendly vehicle for a threat vehicle and vice versa. Therefore, for the final phase of the research, a self-instructional program in target identification was developed. A slide/tape format was employed, and the program proved to be highly successful. In order to produce the training imagery needed for this training program, a montage technique for producing realistic imagery for training purposes was developed by Foskett and Ton (1979).[10] The technique involved the combination of photographs of model vehicles with photographs of real terrain permitting training personnel to display a variety of vehicles in realistic tactical deployment. The resulting R&I program was designed for use with a Singer Caramate II. An accompaning sound track guided the learner through the program, and pointed out those distinguishing characteristics which could be observed in each visual presentation. Even though much of the imagery was copied from training literature, the technique for presenting the imagery of both friendly and threat vehicles in the same terrain scene (montage) was developed specifically for the target handoff research. The original training programs required 40-45 minutes to complete; they were later expanded into two modules requiring 40-45 minutes each to complete.

Following the completion of the work in target handoff and recognition and identification, the staff of the 6th ACCB requested that a basic training program in ground vehicle recognition and identification be developed. To the extent possible, the techniques employed in the field research were to be adapted for classroom use. The objectives for the program were developed in a joint meeting between staff personnel from the 6th ACCB S-2 Office and their Threat Center, and the ARI/support contractor research team. The objectives were as follows:

- To develop a modular type training program; each module to be a short training block which could be administered within a short time period (i.e., a 50-minute class period).

- To provide a training program which would involve a minimum of supportive materials and impose no undue demands on instructor participants.

- To employ the same principles which had been used successfully in the field research.

- To conduct the training in a more realistic fashion by teaching aircrews to recognize and identify armored vehicles using the same image sizes that would be seen under actual field conditions.

A target array of 25 vehicles was selected by 6th ACCB personnel for inclusion in the program. The array included U.S. vehicles, vehicles from nations considered to be threats, and vehicles from European nations allied with the Unites States. The program was designed primarily to provide training in armored vehicle recognition and identification at extended (2000-4000 meters) ranges for air cavalry personnel whose duties encompassed aerial observation. However, it was realized that it could be useful to other elements of the Army.

The program consisted of five basic modules, each designed to develop R&I skills for five of the 25 vehicles. A sixth module, a test for all 25 vehicles, was added. The imagery was presented to the soldier via 35mm slide projection. A general Instructor's Guide and a separate Instructor's Guide for each of the six modules, were included as part of the program. The guides for each module contained a script for each slide that could be used verbatim by an instructor.

The developed program, titled "Long Range Target Recognition and Identification Training Program" (Warnick and Kubala, 1980),[11] was turned over to the 6th ACCB in the fall of 1978. This program became the prototype for further development and research.

The 6th ACCB was not the only organization to recognize a need for improved R&I training. The Armor School at Fort Knox and the U.S. Army Intelligence Center and School at Fort Huachuca had also identified an overall need to improve R&I skills as weapons systems improved. In addition, Forces Command's (FORSCOM) Opposing Force Training Detachment, Red Thrust (Fort Hood, TX), through its Mobile Training Team (MTT), concurrently found that neither active Army nor the Reserve components had a standard R&I training program, although such a need was expressed. Upon hearing of the 6th ACCB program, Red Thrust included a description of the vehicle training program in their briefings, and found an immediate expression of interest. These briefings started a "grass roots" movement throughout the Army for improved R&I training. Based upon the expressed interest, the ARI Field Unit at Fort Hood initiated a program of research in ground vehicle recognition and identification. This program was called the Target Acquisition and Analysis Training System, or TAATS.

The first effort in the TAATS program was an evaluation of the prototype CVI program developed for the 6th ACCB. Details of this evaluation are presented in Chapter 2.

Chapter 2

DEVELOPMENT OF TRAINING FOR TARGET ACQUISITION AND ANALYSIS TRAINING SYSTEMS (TAATS)

Description of the Basic Combat Vehicle (CVI) Training Program

From the experience with the 6th ACCB, a Basic Combat Vehicle Identification (CVI) training program was developed. The Basic CVI training program contains a looseleaf binder with nine individually bound booklets. The first booklet, entitled "Instructor's Guide," describes the program and provides all the information necessary for its use. The remaining booklets are appendices to the Instructor's Guide. The first appendix contains sample work and answer sheets which can be duplicated locally. The next six appendices, each with a carousel of 35mm slides, comprise individual training modules which can be used independently. Each of the first six modules was designed to train the soldier to recognize and identify five combat vehicles. The training modules can be administered in any order. In fact, six different groups can use the program simultaneously, if classroom and slide projectors are available. The last appendix is for use with the Final test module which is administered after training on all modules is completed. The test module contains images of all 30 vehicles in the target array.

The booklet for each of the training modules contains all of the necessary additional instructions for the administration of that particular module which are not included in the basic Instructor's Guide. Each booklet contains a complete script that the instructor should follow exactly. The script includes several statements keyed to each of the slides in the tray. Each statement points out a particular feature visible from that aspect that can usually be seen at tactical ranges. Therefore, the instructor need not be an expert in vehicle recognition and identification to use the program successfully. In fact, demands on instructor personnel are minimal.

Each training module is divided into three sections. The first two sections each consist of 25 slides showing the five HO scale (1:87) combat vehicles in each of five different views: side right, side left, oblique right, oblique left, and front. The third section consists of 15 slides showing the front, an oblique, and one side view of each vehicle.

As mentioned above, each training module is composed of three sections. Section A is called the Manual Presentation Sequence. The vehicles are presented in blocks of five, each block containing all five target vehicles. Views are randomized within each block. In Section A, each vehicle is shown once in each of its five views. However, the soldiers are not aware of the program design as the slides are presented with no interruption between each block of five. During the presentation of each slide, the instructor first asks the soldiers to determine whether the vehicle shown is considered to be a friend or a threat, and indicate this by placing an "F" or "T" on their work sheets under recognition. The instructor also tells them to name (identify) the vehicle if they can. Either the correct alphanumeric designation or its most common name can be used. If the soldiers cannot make these determinations, they also indicate this on their work sheets by writing "DK" for don't know. The instructor then indicates whether the vehicle is a friend or threat (recognition) and names the vehicle (identification). Reading from the prepared script, the instructor points out the distinguishing characteristics or features of the vehicle which can be seen from the particular view shown. Finally, the instructor will answer any questions and then proceed directly to the next slide. The presentation time for each slide in Section A is manually controlled by the instructor to ensure sufficient time for discussion.

Section B consists of 25 slide presentations. The manner of presentation is the same as in Section A, except that the slides are in a different order and they are shown for only 15 seconds each. The soldiers are again requested to indicate whether the vehicle is a friend or threat and to name the vehicle, if they can. During the last few seconds of each presentation the instructor provides the correct answers and other information on each vehicle. Prepared scripts with all the necessary information are included in the lesson plan for Section B. Section B is referred to as the "Automated Presentation Sequence."

Section C is the test for the training module. The test consists of 15 target presentations. Each vehicle in the module is shown three times in a front, an oblique, and a side view. Both viewing angles and vehicles are randomized. Each vehicle is shown for eight seconds. No feedback or information is provided to the soldiers during the test.

The initial module presentation to a group requires 50 minutes. For subsequent modules, where the instructor does not have to explain the entire program, each module normally requires 30 to 40 minutes to complete. More time might be required if the soldiers ask an unusually large number of questions in Section A.

The Final Test, Module 7, contains all 30 vehicles and is administered after the soldiers have received all of the training modules. The slide tray for this module contains 60 slides, 30 of the front view and 30 of an oblique view of the target array vehicles. The soldiers must indicate whether the vehicle is a friend or threat and name the vehicle just as they did in the training modules. Each slide is exposed for eight seconds in the Final Test. The instructor may choose to vary the order of presentation if the soldiers have previously completed the program and taken the Final Test. The Final test module can also be employed as a diagnostic test to determine the initial capability of the class.

Support requirements are minimal. The only materials required other than those included in the training program package are a carousel slide projector, a projector screen, tape measure, and a suitably sized classroom that can be darkened for the presentation.

The prototype training program overcame inadequacies noted in other programs in the following respects:

- Material and instructions are prepackaged and available so that the instructor can simulate any viewing distance from 250 to 4000 meters for a variety of optical magnification devices found on U.S. weapons systems. Thus, the instructor can simulate the tactical ranges at which the soldiers are most likely to engage targets. A table in the Instructor's Guide provides data on eye-to-screen viewing distances for these simulations.

- The 35mm slides all show camouflage-painted vehicles on a multi-colored terrain background. Although the vehicles are not obscured, the setting is quite realistic.

- The vehicles in the program are a mixture of U.S., NATO, and Warsaw Pact combat vehicles. Therefore, the soldiers have to learn to discriminate friendly from threat vehicles.

- Different vehicles are photographed in exactly the same location, with exactly the same background. As a result, soldiers cannot learn to identify the vehicles by memorizing irrelevant characteristics of the imagery. They have to make the identification solely on the basis of the vehicle itself.

Evaluating the Combat Vehicle Identification Training Program

Background

An evaluation was undertaken of the prototype program developed for the 6th ACCB to determine whether its success with helicopter pilots could be generalized to the Army as a whole.

Method

To carry out this evaluation one CVI training package was sent to each of 22 active and reserve military units. Nine responded with usable data by the cutoff date. No special instructions or training was provided that might bias the evaluation of the adequacy of the materials. In this manner, the CVI was placed in the most "normal" environment possible for its evaluation. Data instruments consisted of the tests taken at the end of each training module and the seventh overall test module. Also, an instructors' questionnaire was sent to each unit. A total of 26 instructors completed a questionnaire.

The data obtained from the field were analyzed in two separate efforts. The first by Smith et al (1980)[12] was designed to assess the overall effectiveness of the program in an operational environment and to determine the ease of administration. The second by Heuckeroth et al (1985)[13] was a detailed analysis of factors affecting target acquisition performance which included presentation angle, vehicle, range, soldier rank and MOS, use of glasses on the job, and the tendency for certain vehicles to be confused with one another.

Analyses

Smith, et al. 1980[14] employed analysis of variance and Duncan multiple Range Tests to a) compare CVI training with other Army training; b) evaluate the internal consistency of the modules; and c) evaluate differences between vehicles in terms of difficulty of recognition and identification. Technical and training administration evaluations were obtained from the 26 instructors who used the program in the participating units.

Results

The major results were:

- Soldiers trained with the CVI training program showed significantly higher recognition and identification scores when compared to soldiers not receiving this training.

- Significant differences in the accuracy with which different vehicles were recognized and identified exist among vehicles tested immediately after training (Training Module Tests).

- Both recognition and identification performance showed significant degradation from Training Module Tests to the overall test module. The time interval between original training and subsequent short term retention testing was almost always 1 to 3 days. Some of this degradation, no doubt, was due to the differences in the number of vehicles tested immediately following training (5 vehicles) and in the later overall test (25 vehicles).

- Inspection of mean recognition and identification performance by presentation angle for each vehicle showed that during Training Module Tests performance on frontal views of vehicles was generally poorest, followed in turn by vehicles seen from oblique and side presentation angles.

- Subjective evaluation by instructors of the CVI program reported the program "effective" (27%) or "very effective" (69%).

This field evaluation of the prototype CVI showed that some modifications in the composition of the training program were necessary for it to be maximally useful for the entire Army. The following changes were instituted:

1. Six vehicles were added to extend the array. They were the XM1, BMP, BRDM-2, ASU-85, BMD, and M1974.

2. The Sheridan, M551, was removed.

3. The BTR 50 was rephotographed with the human figures removed.

4. The five new vehicles allowed for an additional module with the necessary training materials furnished. This revised basic CVI

program consisted of 30 vehicles, 5 in each of 6 modules with the seventh module remaining as the training program test. (The experimental module 6 in the prototype, composed of only tanks, was removed.)

5. Module 2 was changed to include two of the new threat vehicles in order to increase the difficulty of the module.

Extended Analysis of the CVI Training Program

Background

The ultimate goal of a detailed analysis by Heuckeroth et al. 1985[15] was to provide guidance for further investigations aimed at improving training in combat vehicle R&I. Some of the highlights from the results and discussion sections are provided below.

Results and Conclusions

Target Acquisition Measures

Consistent with findings reported in earlier work (Haverland & Maxey, 1978;[16] Warnick, Chastain, & Ton, 1979;[17] Smith, et al.,1980[18]) recognition accuracy was greater than identification accuracy regardless of whether testing was accomplished immediately following training or in subsequent Short Term Retention Testing. While the number of vehicles tested in Training Module Tests and Short Term Retention Testing (Final Test) was a confounding variable precluding direct comparison of recognition and identification performance across these test periods, inspection of mean performance scores suggested that identification performance was more severely affected by the passage of time than was recognition. The relatively higher recognition accuracy may be, in part, due to the smaller response set for recognition (Friend or Threat), thereby permitting higher performance scores due to correct guessing; to identify a vehicle, selection had to be made from among either five or 25 vehicles. As long as both recognition and identification remain doctrinal components of the target acquisition process, training should be programmed so as to achieve the desired identification performance level. Soldiers who could name a vehicle almost always knew whether the vehicle was a friend or a threat.

Vehicle Angle (aspect angle)

Consistent with findings reported in earlier work (Haverland & Maxey, 1978;[19] Warnick, Chastain, & Ton, 1979;[20] Kottas & Bessemer, 1980;[21] and Kottas, Bessemer & Haggard, 1980[22]), target identification accuracy on the average was inferior for frontal views of vehicles; this finding held for testing immediately following training and after a short retention period. When comparisons were made by vehicle, in every case where a significant difference existed for a target acquisition measure, performance on the oblique angle was better than the frontal angle for that vehicle. This finding held for both recognition and identification measures and was true during Training Module Tests and the Short Term Retention Tests. While performance for frontal views of vehicles was consistent with subjective impressions of difficulty, it was relevant to note that the CVI training program provides four-fifths of R&I training on side and oblique vehicle views. For many of these latter views, cues that aid in R&I were the same; cues used for frontal views tend to be more unique and receive only one-fifth of total training time. Because of the greater perceived difficulty of R&I with frontal views, providing a closer balance of training on all views would probably reduce the performance differences observed. Performance differences on side and oblique vehicle views during training, however, were not consistent. Recognition performance was greater on the average for side vehicle views; identification was superior for oblique vehicle views.

Vehicle Type

Findings reported for differences in target identification performance for vehicles immediately following training and after a short retention period were too numerous to summarize in any detail in this report. Suffice it to state that the results indicated significant differences in ability to learn different vehicles for recognition scores, F (24, 3144) = 5.91, $p < .001$, and for identification scores, F (24,3144) = 7.12, $p < .001$. The M60A1 was the easiest to identify and the BTR60P was the most difficulty to identify following training.

Rank

The most salient finding with respect to target acquisition performance for soldiers differing in rank was the generally poorer performance of the E1 soldier and the trend (although not significant) for this performance to improve with increases in rank. This finding was interpreted as probably due to a combination of increased ability of soldiers at higher ranks and increased understanding of terminology used in CVI training program scripts. The high motivation expected of career soldiers may also have played a role.

Glasses

The most important finding in this set of analyses was the tendency (supported by significant results during Short Term Retention Testing) for soldiers who wore glasses to evidence superior target identification performance. In studying the range at which targets could be detected with West Point cadets, O'Neill and Johnsmeyer (1977)[23] found similar results. Rather than indicating that wearing glasses, per se, resulted in improved recognition and identification performance, this finding was interpreted as consistent with the inference that many soldiers (who do not currently wear glasses) should be wearing glasses. It was suggested that either more frequent or more careful vision testing among soldiers would be desirable--especially for those requiring high proficiency in R&I skills.

Range

During Training Module Tests there was a tendency for both recognition and identification performance to improve with increases in range. The trend was supported by a significant finding for recognition performance during Short Term Retention Testing; identification performance increased through 1500 meters and declined slightly thereafter.

In exploring possible reasons for the counterintuitive trends in this work, a model which assumed that target identification performance was a function of the consistency of verbal and visual training cues, and the amount of information to be processed, was suggested. Since the CVI program was designed to train target acquisition at standoff ranges, the scripts used by instructors during these training modules tend to highlight only those cues which would be seen at those standoff ranges. At the near presentation ranges, the cues highlighted in the instructor's script were only a few of the many available, and the soldier may have more difficulty in focusing attention on only those cues. While the poor performance exhibited at the shorter ranges can be interpreted by this analytic model, it is certain there was a point beyond which increases in target acquisition training/testing range will result in performance decline.

The significance of range to training is that as the target gets smaller, the number of visible cues decrease until at ranges of 2000 meters or more, only the turret and chassis can be distinguished. It is therefore critical that the cues which are visible are stressed throughout training at any range. Vehicles can be recognized and identified at these greater ranges if the training is done correctly.

Evidence was found to support the expectation that at ranges of 2000-4000 meters, when proper cues are taught, no performance decrement results from training and testing at different ranges.

Two studies conducted by Kottas and Bessemer (1980)[24]; and Kottas, Bessemer and Haggard (1980)[25] addressed the question of the band of ranges for which training at any given range would be effective. Using training/test ranges of 2000 and 4000 meters, Kottas and Bessemer reported no significant differences. Follow-on research by Kottas, Bessemer and Haggard using only data where pretest scores were roughly equivalent, noted that the target identification performance increase for soldiers trained and tested at 2000 meters showed little difference when compared to the performance increase of soldiers trained at 2000 meters and later tested at 4000 meters. Results presented here show that the closer training resembled test range condition of the target at tactical ranges (1500 to 3000 meters) the more easily it was generalized.

Vehicle Similarity

Greater insight into the complexities of R&I performance was gained by an analysis of which vehicles were most often confused with other vehicles. Through this procedure it was possible to consider means of modification of training to emphasize differences or increase training for some vehicles and decrease it for others. A review of confusion matrices indicated that the potentially most dangerous vehicle confusions were:

Friendly		Threat
AMX30	with	T62
AMX30	with	T72
Leopard	with	T72
Gepard	with	T72
Marder	with	T72
Scimitar	with	T72
Jagdpanzer	with	T72
Saladin	with	BTR60
M48	with	T54/55

Research Leading to the Advanced CVI (Masking) Training Program

Background

The imagery developed for the Basic CVI showed the vehicles in full view under what could be termed "nearly ideal" viewing conditions. Throughout the development of the CVI, comments from knowledgeable Army personnel (senior field commanders) indicated that the viewing conditions were too ideal. The research team was urged to produce additional programs which presented the vehicles in more tactically realistic situations. Particular interest was expressed in a program which trained soldiers to identify vehicles in hull defilade, as they would likely be seen in a defensive position. Interest was also expressed in an identification training program which showed vehicles partially obscured by dust, smoke, fog, vegetation (other than hull defilade), and any other tactically realistic degraded viewing conditions. The research team decided that the first priority would be to develop a vehicle identification training program for vehicles in hull and turret defilade.

Method

At the outset, it was not known how much of a vehicle could be masked before it became virtually unidentifiable. The research team wanted to select masking levels which were realistic. Therefore, the first step in the research was to select the masking levels for which the training imagery would be developed. Five levels of masking were chosen for study (Kubala, Warnick, & Merryman, 1981).[26] The lowest level masked only that portion of the vehicle from approximately axle or mid-wheel to the ground. This level was chosen as, in the research staff's judgement, recognition and identification performance would be very minimally, if at all, affected. The highest level of masking placed the mask just below the main gun tube. This is the maximum degree of masking compatible with the use of direct fire weapons. The other levels fell between these extremes. Masking of the HO scale vehicles was accomplished by placing what appeared to be a cement wall in front of the vehicles. Each vehicle was photographed at all five masking levels in three views (one side, the opposite oblique, and the front).

Ten armored vehicles comprised the test set. Two simulated ranges (1200-2000 meters) were employed. The size of the vehicle images was the same as would be seen through an 8 power optic. The participants, who were all officer aviators (n=27), were chosen for two reasons. First, they typically had a high level of motivation for learning their jobs, and second, they received R&I training on a more or less regular basis. Therefore, they could be brought to an acceptable level of R&I performance on unmasked views in a relatively short time.

There were two research objectives: One objective was to determine how much of a vehicle could be masked before soldiers could not be expected to identify it following a reasonable length training period. A second objective was to determine what cues soldiers could use to reliably identify partially masked vehicles.

Results

Phase I, Full View Training Procedures

In Phase I, the following sequence was used:

(1) Pretest consisting of 30 full views, three of each vehicle (an oblique, the opposite side, and the front).

(2) Sixty training trials employing the full view imagery and scripts from the CVI training program.

(3) Mid-training test.

(4) Thirty additional training trials.

(5) Posttest identical to the pretest.

The purpose of the full view training was to ensure that the participants were able to recognize and identify the vehicles before attempting to determine how much of the vehicles could be masked before they could not be identified with reasonable accuracy after training. The aviators were divided into two groups. One group viewed the images at a scaled range of 1200 meters and the other at 2000 meters.

Table 3 presents the results of this phase of the research. As can be seen, both groups improved in their performance considerably. However, only the group at 1200 meters scaled range achieved the 90 percent criterion desired on the posttest. The difference between the posttest means is statistically significant ($t = 2.35$, $p < .05$). This is rather an unusual finding. In previous research (Haverland & Maxey, 1978;[27] Warnick & Kubala, 1979;[28] Smith, et al., 1980[29]), posttraining performance of groups at different scaled ranges up to 3000 meters or more have varied only minimally.

Table 3

Identification Test Scores (Mean Percent Correct) for Full View Training

Range	Pretest	Middle Test	Posttest
1200M	59.5	90.3	92.6
2000M	41.2	76.4	84.5
Both Ranges	50.5	83.1	88.4

Phase II, Masked Training Procedures

In Phase II, the following sequence was used:

(1) Pretest. Same pretest as phase I except the vehicles were all masked at the middle masking level.

(2) First training session (150 slides). The slides consisted of three views (oblique, side and front) of each vehicle at all five masking levels. Each slide was presented and time was allowed for the aviators to write their responses. They were then told whether the vehicle was a friend or a threat and given the name and/or alpha numerical designation.

(3) Second training session (150 slides). During this session the participants who correctly named the vehicle were asked to state what cues they used to identify each vehicle. Participants who misidentified vehicles were asked what cues or characteristics misled them. These responses were recorded by a training assistant. The recorded material was later collated for use in developing the scripts to go with each slide in the training program.

(4) Posttest. Identical to the pretest.

The results of phase II are shown in Table 4.

Table 4

Identification Test Scores (Mean Percent Correct) for Masked View Training

Range	Pretest	Posttest
1200M	75.9	97.9
2000M	47.1	80.7
Both Ranges	61.0	89.0

The difference between the posttest means of the two groups was not subjected to statistical treatment due to the ceiling effect. Nine of the 13 pilots at the 1200 meter range made no errors on the posttest. Errors for the 2000 meter group ranged from 1 to 11.

Table 5 shows the mean percent correct identification for each mask level for the two training sessions. The means shown are for the entire 150 slide training sessions.

Table 5

Identification Scores (Mean Percent Correct) for Each Mask Level by Range Level for the Two Training Sessions

	First Session			Second Session		
Mask Level	1200 M	2000 M	Both Ranges	1200 M	2000 M	Both Ranges
1	85.6	64.5	74.7	87.7	67.9	77.4
2	81.5	64.8	72.8	83.0	71.2	76.9
3	77.2	59.0	67.8	80.8	71.2	72.6
4	71.5	46.7	58.6	72.6	58.1	69.9
5	64.4	31.7	47.4	74.9	40.2	56.9
	76.1	53.3	64.3	81.8	60.5	70.7

It can be seen that little improvement in vehicle identification occurred at the first three mask levels for participants at the 1200 meter scaled range. More improvement is evidenced at the two most difficult levels. Moderate improvement occurred even at the easier mask levels for the group at the 2000 meter scaled range. However, again, greater relative improvement took place at the two most difficult mask levels.

It was decided to use mask levels 3 and 4 for further development of the mask training programs. There were several reasons for choosing these levels. First, there was very little difference in the performance of the participants on mask level 1 through 3, so only one of these levels seemed necessary. Of the first three, mask level 3 was chosen as it provided the greatest masking of the three. Mask level 5 was dropped for two primary reasons. Identification scores for the group at the 2000 meter scaled range averaged less than 50 percent. It was felt that this level would discourage soldiers and result in poorer performance. The second reason was the comments made by participants at the 2000 meter range. Many of them stated that they could not have even seen the vehicle had they not known exactly where to look. Therefore, it seemed likely that even detecting stationary vehicles masked at this level would be difficult at longer tactical ranges, so there would be few opportunities for identification.

Another consideration in choosing the levels was the type of personnel who participated in this research. Pilots are typically highly motivated and reported to the experimental sessions with above average identification skills. Therefore, it was felt that the performance of the participants in this research was considerably better on the masked views than could be expected of more typical soldiers whose missions do not place such high priority on the R&I task.

Description of the Advanced CVI Training Program

Based on the results just described (Kubala, et al., 1981),[30] the Advanced CVI training program was built using the new data and the same composition and training principles found in the Basic CVI. The advanced program showed vehicles partially obscured from view by natural terrain features. Each of the six training modules used 5 of the 30 vehicles photographed at two levels of masking for each of three different positions (front, oblique left and oblique right). One mask level obscured that portion of the vehicle from just beneath the main weapon to the ground. On vehicles which were flat on top and had no turreted weapon (e.g., the M113 or BTR-60P personnel carriers), obscuration started from below the top deck to the ground. Another mask level obscured the vehicle chassis. Exposed portions of the vehicles were held relatively constant across all vehicles, taking into consideration the type and design of each particular vehicle.

Evaluation of the Advanced CVI Training Program

Method

The Advanced CVI Training Program (Masking) was tested by training two groups of personnel with the Advanced Program and a third similar group with the Basic Combat Vehicle Identification Training Program.

Analysis

Analysis of variance designs were used to assess the effectiveness of the Advanced Program, the impact of various military, demographic and other background variables on target identification performance and to compare the effects of training on the Advanced with the Basic Combat Vehicle Identification Training Program.

Results

The overall effectiveness of training was assessed in a within-subjects analysis of variance with target acquisition measures (recognition and identification) and test period (pre- vs. post) as within-subject factors. The number of correct responses was the dependent measure. Results produced a significant main effect for time of testing [$F(1,23=72.07, p<.001$], indicating that posttest scores (22.1% correct identifications) were improved over pretest scores (1.5% correct identifications) after the training; a significant main effect for target acquisition measure [$F(1,23)=2622.29, p<.001$], implying the identification response is the more difficult; and a significant interaction between these two effects [$F(1,23)=6.19, p<.02$] suggesting that there is more improvement in the identification scores as a result of the training than in the recognition scores.

The effectiveness of the Advanced CVI was further supported by the rating data collected. Of the 46 trained personnel, 52 percent found the training "very effective"; 39 percent found it "effective"; 9 percent found it "neither effective nor ineffective"; none found it "ineffective" nor "very ineffective." When asked to compare the Advanced CVI with previous identification training they had received, 59 percent evaluated it as "much better"; 27 percent found it "better"; 14 percent found it "about the same"; none found it "worse"; and none found it "much worse."

Comments from the field also indicated that commanders desired programs which covered different geographical areas and different environmental and atmospheric (smoke, haze, fog, scintillation) conditions. The TAATS research team did some preliminary work in attempts to simulate different environmental conditions and produced some prototype imagery for haze and fog obscuration and the optical effects of scintillation. However, other priorities did not permit the full development of the simulations and the subsequent development of separate programs.

Discussion and Conclusion

It was concluded that the personnel benefited significantly from their six hours of training. While the changes in recognition scores were not as dramatic as identification scores, identification performance increased by a factor of some 14 times (1.5% correct on pretest and 22.1% correct on posttest).

Basic Thermal Combat Vehicle Identification Training Program

Background

In November 1982, in response to urgent requests from commanders in Europe and the Deputy Chief of Staff for Training (DCST) at the Training and Doctrine Command (TRADOC), the Army's proponent for recognition and identification requested that the highest priority be given to the development and testing of training that would prepare soldiers to recognize and identify the key characteristics of infrared (IR) vehicle images. The impetus for this request was the acquisition of new IR sights for the U.S. M60A3 tanks with no supporting training for R&I to accompany them. A crash effort was undertaken and within eight months the Basic Thermal CVI Training Program was developed and then tested in Europe.

Development Problems

In order to develop the training program, thermal sight images were badly needed. A search was conducted but met with little success. Few of the images obtained met the research team's requirements for the following reasons:

- Virtually no unclassified imagery of modern Warsaw Pact vehicles was available, and imagery of NATO country vehicles was extremely limited.

- There was no consistency in the ranges or viewing angles from which the imagery was obtained.

- Backgrounds were very dissimilar, making the images easy to identify without regard for the characteristics of the vehicles.

- The preponderance of the imagery was in the "white hot" mode, but the newer thermal sights have both white hot and black hot settings. In the white hot mode, any part of the vehicle which radiates heat shows up as white. In the black hot mode, the hot areas show up as dark on a lighter background.

- The contrast and brightness controls were typically set to maximize the contrast between the vehicle and the background. This maximizes the likelihood that the target would be detected, but such imagery was judged to be of little use for R&I purposes. This was noted by Ratches and Swistak (1972).[31] They obtained imagery with the brightness and contrast set for detection and found that it "caused blooming of the target which degraded the edges of the target. This blossoming also hurt recognition...." In other words, the target appeared to lose its shape, and shape is the most critical characteristic for R&I purposes (Foskett, et al., 1978).[32]

- The quality of the white hot image seemed to be extremely susceptible to factors such as ambient temperature, ambient lighting, and other atmospheric conditions.

Based on these findings, it became obvious that the imagery for the thermal R&I program would have to be simulated. In fact, the lack of any imagery for a number of vehicles alone dictated a requirement for simulation. In order to obtain a better fix on the capabilities of thermal sights for producing imagery more suitable for recognition and identification, the research team took a total of nearly 3000 photographs of a limited array of vehicles through three different types of thermal sights [the thermal surveillance sight (AN/TAS-6); the M60A3 tank thermal sight (TTS); and the M1 thermal integrated sight (TIS)]. Five views of each vehicle at eight ranges were obtained. For each image, the sight controls were reset to maximize the shape characteristics of the vehicle. It was noted that the black hot image remained more stable. That is, less blooming occurred and the shape of the vehicles could be determined more easily at the longer ranges. Essentially, the vehicles appeared as black silhouettes on a light green background. Therefore, it was determined that the black hot mode would be employed for the simulations. A simulation technique was developed based on one of the actual images of an M60A3 tank. This was done by placing a vehicle model on an underlighted sheet of translucent plastic. A video camera set on high contrast viewed the scene and displayed the image on a high resolution black and white monitor. The monitor was photographed, and the green color representing the phosphor in both tank sights was added in the developing process. Imagery of all 30 vehicles in the basic CVI was obtained in this manner.

The next decision involved the choice of a presentation medium. The use of videodisc technology with microcomputer control was considered. However, few units in the Army had access to this kind of equipment. The decision was made to use 35mm slides. Previous experience with Army units suggested that slide projectors were the only audiovisual equipment likely to be available to all units needing the training, although even these were sometimes found in short supply.

Program Description

The format of the Thermal Combat Vehicle Identification (TCVI) program (Smith, et al. 1983)[33] was very similar to that of the Basic CVI. There were six training modules and a final test module. However, some changes were made. Each training module had four views (side left, oblique right, oblique left, and front) instead of five for each of the vehicles. During the module training the simulated thermal images were presented in combination with comparable views of the photopic image of each vehicle from the Basic CVI program. The twenty 35mm slides (five vehicles x four views of each) of each training module were shown twice, once with exposure controlled by the instructor (Section A) and a second time at 15 second intervals (Section B). Each module had a test (Section C) composed of only thermal images of the five vehicles (four views of each) shown at 8 second intervals. The Final Test (Module 7) of the 30 vehicles (two views each, the front and one oblique) using only the thermal images exposed at 8 second intervals provided an overall measure of the training progress. All instructor materials were provided with the program, including scripts for each module.

In other CVI programs which relied on photopic visual images, sizing of the image was stressed as being of utmost importance to simulate range accurately. This was because the image, as it is made larger, showed more and more detail and it was of great importance that the soldier only saw those details (cues) that would normally be visible at extended ranges. With the thermal image, however, no increase in detail occurs by enlarging the image. This is because the maximum amount of detail available is only that which can be captured by the monitor. Therefore, sizing is not critical and was not emphasized for the TCVI. The only size requirement was that the vehicle image be a size that all soldiers in the classroom could see without difficulty.

Results

Two test sites in Europe were employed. At one site, the objective was to determine whether the TCVI program was effective. Significant increases in both recognition and identification accuracy for the simulated thermal images were observed following training. Table 6 presents the results from this site.

Table 6

Comparison of Pre- Posttest Recognition and Identification Performance Scores*

	Recognition		Identification	
	M	*SD*	*M*	*SD*
Pretest	81.90	1.46	18.61	6.68
Posttest	97.10	13.78	40.69	17.68

*Maximum possible score is 120.

At the second site the objective was to determine whether the Basic CVI program should be administered before administering the TCVI program. This question was raised because of the fact that the Basic CVI is essentially incorporated in the TCVI training. In order to address this question, performance on a post-postest, the test administered after training when both programs had been completed, was examined. Mean performance on the photopic images for recognition using the sequence of Thermal-CVI, was compared with its counterpart using the sequence of CVI-Thermal. In a like manner, photopic means for identification were compared. Similar comparisons for the thermal images were made. In each of the four comparisons, the *t* statistic failed to attain significance [$p > .05$]. The inference drawn from these tests is that the Basic CVI training is not mandatory as preparation for use of the TCVI. However, the most common order for training is to present the Basic CVI first.

Discussion and Conclusions

No unusual findings came from the data analyses. In fact, the thermal image recognition and identification scores were very comparable to scores obtained in previous work for the Basic CVI. It was concluded that the program was effective, although it was obvious that additional training would be required to bring identification scores up to a desirable 90 percent.

It was further concluded that training on the Basic CVI was not a necessary prerequisite for TCVI training.

An interesting additional finding was that performance decreased as GT* scores fell below 100. The mean percent correct posttest identification score for personnel with GT scores of 100 and over was 65.1. The comparable percent for personnel with GT scores of 99 or less was 32.3. This effect was more apparent with identification than recognition because there was a 50/50 chance of being right on recognition since only two alternatives existed (friend and threat). The performance difference has implications for training and research. The first is that it may be necessary to make provisions for personnel below the GT level of 100 to receive more CVI training. A second is that additional research is needed to be certain that motivation may not account for part of the decreased performance. A third consideration is the possible relationship of GT level to long term memory and its effect on how frequently training must be repeated.

It should be noted that the TCVI program evaluated was never intended to be the final Thermal R&I training program. It was developed in only a few months in order to "get the best program possible into the field as soon as possible." However, the resources to develop a second generation program were not available.

Remotely Piloted Vehicle (RPV) Target Identification Training Program

Background

In 1981, a group from the U.S. Army Artillery School at Fort Sill, Oklahoma, approached the TAATS research team and requested that a recognition and identification training program be developed for operators of the Remotely Piloted Vehicle (Aquila). The program was to be used as part of the Operational Test I of the Aquila. The RPV is a small drone aircraft that carries a video camera and telemetry equipment. The production model was to have a three lens turret, providing the operator with three magnification options. This equipment transmitted digitized imagery to ground control operators who must detect and identify potential targets from the air. It is estimated that potential targets

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[a] GT stands for General Technical and is a score obtained from the Armed Services Vocational Aptitude Battery. It is a composite of scores from tests of verbal and arithmetic ability.

could exceed 300 different items of threat equipment, assorted construction equipment, command and control complexes, and missile launchers, as well as assorted permanent or hardened facilities and support installations.

The research team developed a "pilot program" (Lyons, et al. 1982)[34] to train RPV operators to identify 17 military vehicles used in the test.

Since it appeared that the requirements of the RPV recognition and identification program represented a slightly modified form of CVI training, the present Army Basic CVI training model was used as a point of departure for the development of the test RPV training package. The Artillery School specified that the views used for training were to be from an altitude of 1200 meters at a horizontal range of 500 meters (1300 meters slant range) at 1000 hours (60° sun angle) and 1600 hours (30° sun angle); and from both front and rear oblique aspect angles. The imagery was to include both black-and-white photos and slides taken of the same views over a TV monitor at a "less than broadcast quality" level of image degradation. These degraded images were produced by reducing constrast and focus electronically to the extent that major identification cues could still be distinguished but minor cues disappeared.

Method

Training was given to five separate groups of students at the Artillery School at Fort Sill in two sessions on successive days. In addition to the pre- and posttest, participants were given two shorter tests during training. These mini-tests were to assess progress and to provide a means for student participation in a discussion of identification cues. Class drills were used for the first time in this training program. Each class was asked to call out the name of the vehicle as quickly as they could each time a slide appeared. As soon as it was correctly identified, the instructor would say "right" or, if identification had not been made, the students were made to recite some of the cues which they saw. If the students could not provide the cues, the instructor did. When the whole class could name the vehicle, the cue discussion was stopped. It was found that the drill should be stopped when the whole class could identify the vehicle in two to four seconds. When it appeared that an individual was not participating, that person was called upon by name to provide answers for the next five or six slides to ensure each was in fact learning the cues.

As in the Basic CVI program, the answer sheets provided a column for friend and threat recognition, and one for vehicle name (identification) or type classification. Type classification was defined as being able to name the target as a truck, tank, self-propelled weapon, etc. Since the RPV would normally operate behind enemy forward dispositions, it may not be necessary to dwell on the friend and threat distinction. But it is essential to be able to type classify, or preferably, name specific items.

Results

The students' average ability to correctly classify the vehicles improved from a pretest mean of 20.75 slides to a posttest mean of 67.45 slides

Those students with the top GT scores did significantly better in learning names, but not in type classifying.

Discussion and Conclusions

Results of the training program evaluation showed that with as few as four hours on the 17 vehicles with simulated RPV imagery using 35mm slides, identification scores can be increased at least 3.25 times.

Learning the vehicle identification cues was not particularly difficult, however, associating those cues with the specific vehicle nomenclature took longer and appeared to be best accomplished in a short time through repetitive drill.

Although GT discriminated among soldiers when highest scores were compared with an equal sample of low scores on the identification performance measure, GT did not discriminate on the classification measure. The failure of GT to discriminate for classification may result from the fact that the artillery mission focuses on the class of targets rather than individual names, as with "Tanks" rather than a particular type of tank, the T62 for example. Hence if GT scores are used to select RPV operators, this criterion would have to be predicated upon some RPV operator functions besides just image identification, particularly if type classification is the major consideration.

Discussions with the participants indicated that the repetitive drill was welcomed as an effective way of quickly associating vehicle names with specific sets of identification cues, and was not considered boring or demeaning by the participants.

Basic CVI Flashcards

Background

The use of recognition and identification playing cards was widely used in World War II, especially for aircraft R&I. In some cases they were designed to be used as playing cards and in other instances were developed mainly as a cheap and portable means of sustainment training for individual servicemen. Most of them had the target vehicle printed as a black silhouette.

The Army proponent for R&I requested that the Basic CVI slides be made into a "flashcard" set. Cards such as these are more typically employed as a supplement to formal training. Little, if any, formal evaluation of sustainment aids has even been conducted. This evaluation (Lyons & Miller, 1982)[35] of the CVI flashcards was one of the first efforts to assess their utility when used in essentially unsupervised practice. Each set consisted of 60 playing sized cards, with one front view and one left or right oblique view of each of the 30 vehicles in the array. The imagery was taken from the Basic CVI and the cards were printed in color with a simulated terrain background.

Method

Three test groups were organized into:

(1) Group A (n=30) was given the flashcards and a half-hour of instruction suggesting ways for using the cards. The strategy in this instruction was to first divide the vehicles into major groups and subgroups (e.g., main battle tanks, subdivided into those with square shapes vs. those with rounded contours). As the soldiers laid out the cards for each subgroup on a table, the instructors discussed the distinguishing characteristics of the subgroups and individual tanks. Thus, this method provided simultaneous comparisons of similar vehicles, for which the flashcard medium is especially suitable.

(2) Group B (n=32) personnel were issued the flashcards and was otherwise treated like group A, except they did not receive the half-hour instruction.

(3) Group C (n=18) personnel received no cards or training during the research period, but they did take the pretest and posttest.

Each of the three groups took the pretest and then 10 days later, they took the posttest. Results of these two tests were compared to determine if R&I skills improved.

Results

Table 7a shows the results for each group on friend/threat determination and Table 7b shows the results for each group on target identification.

Table 7a

Friend/Threat Determination

	Group A (n=30)		Group B (n=32)		Group C (n=18)	
	Pre	Post	Pre	Post	Pre	Post
M*	69.0%	77.1%	70.6%	74.7%	73.1%	72.6%
t	4.01		2.79		.28	
p	<.01		<.01		>.05	

* Percent of 60 slides correctly recognized.

Both groups (A & B) achieved a statistically significant improvement on pre/posttest comparison of the friend/threat discrimination portion of the test. But group A's improvement was greater than that of group B, indicating that the instruction was advantageous in using the flashcards. But performance of group

C (control) actually dropped slightly, indicating that testing by itself did not improve performance. Therefore, the significant improvement of the other groups was apparently the result of their practice with the flashcards, and not from testing and retesting.

Table 7b

Vehicle Identification

	Group A (n=30)		Group B (n=32)		Group C (n=18)	
	Pre	Post	Pre	Post	Pre	Post
M*	3.70%	11.1%	4.15%	8.0%	4.50%	6.38%
t	3.39		0.54		0.55	
p	<.01		>.05		>.05	

* Percent of 60 slides correctly identified

Only Group A showed a significant improvement in identification scores, although both Group B and Group C showed some improvement (See Table 5b). The improvement exhibited by Group A was quite modest. However, it must be remembered that the group received only one half hour of instruction. Personnel receiving the regular classroom training with the Basic CVI would normally have six periods of instruction.

Discussion and Conclusions

It should be noted that this study did not actually evaluate the flashcards in the role for which they were intended. That is, it did not evaluate their effectiveness for sustainment training. To do so, the soldiers would have had to receive CVI training before being issued the cards. Since this was not done, the evaluation actually provided information on the cards only as a "stand-alone" training device.

If the Army invests in production of flashcards, it would seem only prudent to make their use mandatory. Practice with the cards is apt to be especially effective if soldiers know they will later be tested on the vehicles.

An important advantage of flashcards as a medium is that they can readily provide simultaneous comparisons of similar vehicles, which are the ones most apt to be confused. Thus, flashcards provide an opportunity to eliminate many sources of confusion. The instruction given group A, which improved the most, depended heavily on a strategy that involved comparisons among views and grouping of vehicles to reveal both common characteristics and differences. Only group A, which was taught to arrange the vehicle in groups or "families" having similar characteristics improved significantly in vehicle identification (naming the vehicles).

Chapter 3

FACTORS THAT AFFECT COMBAT VEHICLE IDENTIFICATION TRAINING

Effects of Target Motion on Recognition and Identification Performance

Background

The major objective of TAATS was to provide a framework within which to develop a series of interrelated target acquisition training programs. Five were developed, tested, and turned over to the Army. The imagery used in each of these programs was derived from 35mm photographic slides of combat vehicles in static positions. As the TAATS work program developed, the question of using target motion to aid in the recognition and identification (R&I) process constantly surfaced. Conventional wisdom held that when motion was added to training programs using static imagery, performance was substantially improved. Certainly, motion does add realism to the extent that moving vehicles are frequently confronted, and because movement generally attracts attention, motion may have some motivational effects on performance. Research findings in the vehicle visual detection area (Smith, 1951;[36] Gottsdanker, 1957;[37] Miller, 1960;[38] and Gutman, et al., 1979[39]) usually concluded that targets were more likely to be detected when in motion than when static and greater detection occurred as the target shifted from a static to a motion state, when other factors such as target shape and size, contrast, clutter, etc., were held constant. Merrill and Bunderson (1981, p. 4)[40] point out that "motion is necessary only if movement is a critical attribute required for proper discrimination." Generally, motion in R&I training was used to train pilots or aerial observers to R&I aircraft or ground targets, or ground observers to R&I aircraft targets. In both of these situations motion was inherent in the observer or the target. Little research has been done on how motion itself contributed to R&I performance against ground targets.

In the military training community, the value of using motion for training R&I was a generally accepted premise. This was due to the fact that training program developers believed that replicating the actual job environment under which R&I skills had to be used would contribute to learning. Thus, it was believed that the training environment should be designed to duplicate the job environment to the extent possible. However,the development of R&I training media using motion is much more difficult and expensive than using static images. If motion were <u>not</u> required to achieve improved R&I performance, the cost of R&I training material preparation, production, and supportive audiovisual equipment would be substantially less.

Purpose and Scope

The central question Smith et al (1987)[41] attempted to answer was whether training with targets in motion resulted in better R&I performance than that achieved with static vehicle targets under similar environmental conditions.

The major objectives of the research were to determine:

1. whether introduction of motion into the Basic CVI Training Program produced better performance following initial and repeated training,

2. whether motion might improve retention of R&I materials,

3. whether motion might facilitate learning by soldiers who demonstrate difficulty in acquiring R&I skills.

An additional objective was to examine a concept given the name "Training Responsiveness." Throughout the TAATS research effort it was noted that some soldiers have great difficulty in acquiring R&I skills while others do so with relative ease. This observation suggested that some soldiers were simply not responsive to R&I training as currently provided. It was hypothesized that some quantifiable personal characteristics would be related to training responsiveness.

Method

Procedures

Four groups of soldiers (30 per group) were trained on three training modules from the Basic CVI. For this research the three training modules were put on videotape in order to standardize the presentation medium for all four groups. Each group was trained on one of four vehicle conditions: (a) rotation motion, (b) circular motion, (c) straightline motion, and (d) standard static images.

In the rotation group, vehicles were rotated about the center of their axis, completing a 180^{o} rotation in 7.5 seconds. The vehicle aspect view obtained was from one full side to the other full side. Both clockwise (CW) and counter-clockwise (CCW) rotations were employed. During the training each vehicle was shown for a 15-second period utilizing both the CCW and CW rotations. Testing was accomplished using the CW and CCW rotations separately. In posttesting, where the static display sequence called for a front view, the vehicle was presented CW; where an oblique view was to be presented, the vehicle was shown CCW. Exposure time for each vehicle was held constant across all three motions and static conditions--during both training and testing.

In the circular motion group, vehicles traveled through a 180^{o} circular path in a 15-second period for the training imagery. The view was seen from one full side to the other full side. Both CW and CCW movements were employed. Each vehicle moved at a scaled ground speed of 8 mph. Testing imagery was the same except that the vehicle traversed a 180^{o} arc in 7.5 seconds. In order to keep the ground speed at a constant speed of 8 mph, the diameter of the arc traversed was one-half that employed in the training imagery so that the travel time was halved.

For the straightline motion group, training imagery consisted of 15-second sequences with the vehicle following straightline paths. Five paths were used. These paralleled the five views seen in the Basic CVI program: (1) left side (movement right to left), (2) right side (movement left to right), (3) left oblique (movement from far right to near left), (4) right oblique (movement from for left to near right), and (5) front (movement far to near). The testing imagery consisted of 7.5 second views edited out of the 15-second views used for training.

In the fourth group, the standard (static) CVI imagery was used. Exposure times were the same as for the other three groups.

All four groups participated in three separate training sessions. Each session covered all three modules employed in the training. Posttests were administered after the first and third sessions. Slides (static imagery) were employed for posttests for all four groups. A retention test was administered the following day.

Personnel

Personnel who participated in the research were from the 1st and 3d Brigades of the 85th Army Reserve Division (Training) at Arlington Heights, Illinois. The 85th Division, in case of a national emergency, would be responsible for armor training.

Final group sizes were: rotational, $\underline{n} = 16$; circular, $\underline{n} = 19$; straightline, $\underline{n} = 15$; and static, $\underline{n} = 21$. Results of an analysis of variance of GT scores for the four motion groups indicated no significant difference [$\underline{F}$ (3,66) F <1, $\underline{p}$ = > .05] in mean GT scores.

Results

Primary Findings

An analysis of variance was completed on the number of slides correctly identified on the first posttest. Although the group receiving the training with static imagery had the lowest score, no significant differences among the groups were found [$\underline{F}$ (3,63) = 1.79, $\underline{p}$ = .16].

After three training trials an analysis of variance was performed only on the last trial scores. A significant difference among groups was found [$\underline{F}$ (3,63) = 5.77, $\underline{p}$ <.01] with the static condition the lowest group. The differences, while statistically significant, were judged to be so small that further consideration of adding motion to training was not warranted (based upon this data).

Training Responsiveness

For purposes of this research, soldiers who scored less than 50% on the first posttest were defined as being non-training responsive (NTR), while those scoring over 50% were defined as training responsive (TR). The NTR group contained 27 individuals and the TR group contained 44. The results from a comparison of these groups showed:

- NTR soldiers on the average did not score as well after four training sessions as the TR soldiers did after one session.

- NTR soldiers exhibited different patterns of performance improvement between the first and second posttests depending on training condition. Those receiving the rotational and straightline training improved more than those receiving the circular motion or static imagery training [$F(3,63) = 5.91$, $p < .05$].

- A comparison of scores on the second posttest and the retention test indicated no differences in retention between training responsiveness groups.

- Rank and time in service were unrelated to membership in training responsiveness group.

- The TR group contained a disproportionately larger number of soldiers with GT $\geq$ 110. [$X^2 = 13.66$, $p < .001$].

Discussion and Conclusions

- Motion (after repeated training) provides a small positive effect but does not appear to be an essential ingredient in training ground-to-ground vehicle R&I using the Basic CVI Training Program. This was true for both training responsive and non-training responsive soldiers.

- Short term R&I retention is not improved when motion is included in the training.

Effects of Imagery Quality on R&I Performance

Background

The purpose of the TAATS work program was to provide the Army with a series of coordinated R&I training programs. The medium selected for four of these programs was the 35mm slide and the carousel projector. However, many critics of the programs said that the programs used "horse and buggy" technology. They suggested the use of high technology media such as interactive programs employing computers and videodisc players. The research team agreed that computers and video disc players would add versatility to the training. However the decision to use slides was based on a front-end analysis of the

Army's current training capability and the directive from CAC that combat vehicle training programs were required immediately to fill the void with "high tech" advances to follow. The following criteria were mandated by the Army:

- Sufficient fidelity for realistic viewing at simulated ranges of 2000-4000 meters.

- Portability.

- Ease of use (minimal demands on instructor).

- Ability to accommodate both large and small classes.

- Low cost.

- Rapid distribution to all military units world-wide.

The research team investigated the potential for the use of videodisc technology. It seemed highly unlikely that it would be available to company and battalion sized units for years to come because of costs. However, there were potential problems with the slide programs. Slides could be lost, mis-sequenced, or deliberately removed by an instructor. Also, examination of production units revealed considerable variation in color. This made it possible for soldiers to discriminate between slides on color characteristics rather than the characteristics of the vehicles. Although these programs filled an initial void, the Army proponent for vehicle recognition and identification encouraged the research team to investigate media which would alleviate the shortcomings noted with the slide programs.

Two other training media also in use by the Army which might minimize the problems outlined above were the Bessler Cue See (8mm audio cassette) and the standard VCR/monitor combination. However, image fidelity with either of these systems is considerably less than that for 35mm slides. The degradation which occurs is a result of inherent limitations of the equipment. More specifically, in the case of 3/4" U-Matic (cartridge) videotape system consisting of 3/4" tape, tape player and monitor (which is standard for industrial and Army training), vertical color resolution in playback is limited to approximately 250 lines by the electronics of the system. Hence, this system has the greatest potential perceptual degradation.

Two illustrative studies have addressed the effects on image quality as seen on television monitors. Oatman (1965)[42] found a significant difference between 300 and 400 line levels of resolution but no difference among 400, 600, or 800 when target detection was the primary task. Research by Erickson and Hemingway (1970)[43] found that a vehicle image required at least 10 scan lines per vehicle and an angle subtending 14 minutes of arc to ensure a high probability of identification. Direct vision performance was compared with performance on a TV monitor with the result that TV degradation "did not vary with image size but with lines per vehicle and background type." Both the Oatman and Erickson and

Hemingway studies establish the fact that image quality on a TV system can reduce performance and that an increase of scan lines above 250 is advisable in order to mitigate this effect.

Resolution limitation characteristics of 8mm movie film (Bessler) are the same as 35mm slide film with the added disadvantage of a smaller film format (image area). The 8mm film is approximately 1/16 the area of 35mm film and therefore has approximately 1/16 the number of lines of resolution available compared to the 35mm film format. In a good quality 8mm system, horizontal lines of resolution can be over 350. The Bessler equipment, which uses 8mm film, projects the image through a series of mirrors and onto a specially coated plastic screen (rear projection). If the mirrors and screen are not clean additional image degradation can take place.

The resolution characteristics of 35mm slide film are limited mainly by the resolving capabilities of the camera lens used when the pictures were taken, by the projection lens used, and by the type of surface the slides are projected upon. In a good quality 35mm system (camera lens, projection lens, and screen surface), the number of horizontal lines of resolution can be well over 1000.

Purpose and Scope

The main purpose of this research by Smith et al (1984)[44] was to compare the recognition and identification performance of soldiers on three media (35mm slide projector, Bessler 8mm film and 3/4" videotape player) to measure the effect image quality has, if any, on that performance. A secondary purpose was to assess the subjective loss of image sharpness or resolution through cognitive measures of perception. Measures of demographic factors, range and training transfer were taken to assess their impact on performance in the objectives cited above.

Method

Three training modules from the Basic CVI Training Program made up the training content for all three media. Three experimental groups, one group assigned to each of three training media, i.e., videotape, slides, and 8mm film were pretested, trained, and posttested. A fourth group, the control, was pre- and posttested only. All three media were controlled for length of stimulus presentation time.

The Bessler's usual mode of operation is as a self-paced training device used by one individual at a time. In this research two training modes were used but were controlled for length of stimulus presentation time. In the self-paced mode time was restricted to one hour per module. Instructors monitored this phase and indicated that the soldiers followed instructions, completing each training module in the allotted one hour. In the forced-pace training mode, the Bessler was programmed to advance to a new static vehicle image every 30 seconds during training. Although the presentation mode had no bearing on the image quality, it was deemed important to determine the effects of the procedures on performance.

The performance scores of 81 soldiers were used in the data analysis. The personnel were from the 85th Army Reserve Division (Training) at Arlington Heights, Illinois. All the equipment used was "off the shelf" of the 85th Division's Training and Audiovisual Center (TASC). No special calibrations were employed in this research. The equipment represented the average functioning of equipment available to Army units. This was done so performance measures obtained would be comparable to those obtained with equipment used in regular Army training.

The analyses are based on pre- and posttest scores derived from the number of images recognized and identified correctly. Analysis of variance (ANOVA) was the statistical tool used in this research.

Results

The major interest of this research was to determine whether performance may be adversely affected by reduced image quality resulting from projection of CVI vehicle images through media other than the 35mm system.

Media Comparisons

Initially an ANOVA comparing the forced-paced versus the quasi self-paced subgroups on the Bessler was done. As expected, no significant differences for R&I occurred; both "F" tests were <1. In later analyses, both of these groups were treated as one group representing the Bessler system.

No significant differences among media were found for recognition [F (2,78 = 2.59, p = .08] or identification [F (2,78) = 1.17, p = .32].

An independent analysis of each of the three media attests to the robustness of the Basic CVI training program concept in that significant performance differences for R&I did occur from pretest to posttest for each medium.

Demographics

A series of mixed design ANOVAs using relevant demographic characteristics as between subjects variables were employed to assess pre- and posttest performance differences on the CVI training.

The training groups were initially balanced on GT scores provided by the 85th Division. Analysis of pre- and posttest performance by GT scores produced a nonsignificant overall difference for recognition [F(2,71) = .37, p = .70] but a larger effect for identification [F (2,71) = 2.77, p = .07]. The GT by test interaction for identification was also nonsignificant [F (2,71) = 2.85, p = .06]. Rank had no effect on performance differences for R&I. Time in service produced a significant difference for recognition [F(2,77) = 3.22, p = .05], but none for identification. The wearing of glasses produced no differences.

Effects of Range (meters) on Performance

Comparison of the three media at a simulated range of 1500 meters produced no significant differences in R&I performance. No range comparison beyond 1500 meters was possible with the Bessler due to the small image size. Range comparisons with the video at simulated ranges of 1500 and 2500 produced no significant results for either recognition or identification. These results substantiated those found in previous research (e.g., Warnick, et al, 1979)[45]. Also, no significant range by media effects were found [F (2, 30) = 1.10, p = .35].

Transfer of Training From One Medium to Another

A within-subjects ANOVA compared performance on the video posttraining test after completion of training on video with a second posttraining test on slides. The result was significant difference for recognition [F (1,20) = 12.04, p = .002] and identification [F (1,20) = 14.48, p = .001]. It appears that when training has been conducted using the video system, subsequent testing immediately after training with a slide system probably will result in somewhat lower performance. A comparable ANOVA for the Bessler scores showed no differences in performance.

Subjective Evaluation of Image Quality

Six raters (4 senior NCO trainers and 2 majors) observed the training and provided effectiveness ratings on five media characteristics. The Bessler was rated as having a less suitable image while the slides and video were rated as "clear" or "very clear." However, no image was judged to be unacceptably degraded from a training point of view. In the opinion of these raters all three media were judged to be either "effective" or "very effective." When rated on "ease of use," the Bessler was categorized as "marginal" or "somewhat difficult" to use by a trainee. All raters responded to slides as "easy" or "very easy" to use. When asked to compare the suitability of the media for soldiers of differing abilities, a division of opinion resulted from the perceived importance of a "live" instructor doing the training. Bessler and videotape do not normally require an instructor to present the material. Standarized presentation was identified as a useful attribute of video but not at all for the Bessler, which uses a programmed tape cassette. The least liked characteristics for video were the bulk and weight of the equipment which made it difficult to use in the field. Slide images were noted as being unclear at longer simulated ranges and script deviation by the instructor a potentially distracting feature. The Bessler (8mm) had poor quality images and inherent technical design difficulties. It was observed that the Bessler equipment broke down when used for long periods.

The soldiers who were trained gave a subjective evaluation of how well they liked the media on which they were trained. Their responses were: 90% were satisfied or completely satisfied with the video, 70% with Bessler, and 67% with slides.

Self-Paced vs Forced-Pace Performance

The failure to find a self-paced vs forced-pace difference is most easily explained by the experimental constraints placed on the self-paced condition in which the soldier is allowed a limited time to complete the training. This was necessary to control the length of stimulus presentation. Hence, the major characteristic of the self-paced learning situation, i.e., unlimited time, was changed and a modified self-paced condition resulted.

Transfer of Training to the Field

Results showed a lack of perfect transfer for video training when personnel were tested immediately on slides, although much better transfer from Bessler to slides under similar test conditions did occur. These findings raise the often identified issue of how well this training, or any other of like type, transfers to the field or more especially combat.

A field test to measure how much transfer (60% or 70% or 90% or whatever) has been repeatedly suggested and is probably the most straightforward approach to the problem. However, the importance of such testing is diluted by two factors. The first is cost. To conduct a test that would meet minimum design standards could entail a larger number of vehicles from the CVI program. The cost of acquiring these would be prohibitive. The second is that much research on transfer of training has already been done, for the most part assessing the value of simulation devices and training as substitutes for the more costly training in the actual situation. Findings generally suggest that there is transfer but the degree of transfer is dependent on many factors. In few instances was it found that no transfer, or a negative transfer occurred. Therefore, in the budget estimates of many managers, the cost/benefit of such a test is moot.

Conclusions

The findings of this research led to the following general conclusions:

- The quality of images associated with each of the three media (Bessler, video and 35mm slides) is satisfactory for use with the CVI Training Program.

- The Bessler system was less suitable for training during the test because of frequent equipment malfunctions.

- The learning of CVI skills by soldiers wearing glasses or contact lenses is not appreciably different from that of soldiers who do not wear glasses or contact lenses.

- Learning of CVI skills is related to GT scores.

Improved Medium for CVI Training

Background

In the research just described, two alternative media for presenting the Basic CVI Program were evaluated in comparison to the 35mm slide/carousel projection medium. In this effort, reported by Nicholson, et al, (1986),[46] an improved system, the audio filmstrip system, was compared to the standard slide presentation medium.

Purpose and Scope

The objective of this research was to obtain answers to three questions: (1) are there significant differences in the performance scores of soldiers who received CVI training with the Audio filmstrip and the slide system, (2) are differences in performance attributable to soldier characteristics (i.e., GT scores, rank, and age), and (3) do soldiers rate one training system preferable to the other?

Method

Two training systems--one using the standard 35mm Kodak slide projector and the other using the Elmo Audio Filmstrip Projector were compared on the Basic CVI Training Program, using 114 soldiers from the Air Defense Artillery units of the 2d Armored Division, Fort Hood, Texas. Performance scores and subjective ratings were recorded to determine the relative training value of each system. It should be noted that this was largely a comparison of the delivery systems because no apparent difference in image quality existed in that the filmstrip frames were also 35mm in size.

The filmstrip system consists of an Elmo Audio Filmstrip projector, 35-FT (CAP), eight filmstrips, eight audio cassettes and vehicle name cards. All components are enclosed in an aluminum attache case 18" long by 13.5" wide and 6" deep. The entire Basic CVI Training Program was contained in one small easily portable attache case. In addition, a small 8" x 10" projection screen was located on the underside of the case lid. It is possible to modify the filmstrip system and power it by batteries, thus, making it easy to use in field training.

The soldiers were divided into four training groups matched on GT scores. An ANOVA over the four groups showed no significant GT score differences [$F(3,109) = 1.23$, $p = 30$]. All four groups received two days of training. Groups 1 and 2 were first trained on the filmstrip system, while groups 3 and 4 were trained on the slide system. On day two the groups exchanged training systems. Approximately half of the soldiers ($n = 60$) received the slide sessions first and the others ($n = 54$) received the audio filmstrip session first. The training consisted of three training modules from the Basic CVI. During the two days of training each soldier received training on the same three modules taught on both systems. After training was completed on each day, the Basic CVI Final

Test (modified to include only those vehicles in the modules trained) was administered. When training and testing were completed on day two, the soldiers were asked to rate both systems.

Results

Performance of Filmstrip and Slide Systems Groups

Analyses of variance indicated that the order in which the systems were presented had a significant effect on performance when the slide system [$F(1,112) = 33.65$, $p < .0001$] was used first but not when the filmstrip system [$F(1,112) = 0.21$, p 65, N.S.] was used first. These data indicate that performance was enhanced when the participants were subsequently trained on the audio filmstrip system. However, performance was not significantly improved by subsequent training on the slide system.

A chi-square analysis indicated no significant differences among groups on GT scores [X^2 (2, n = 101) = 1.34, $p = .57$, N.S.] or rank [X^2 (1, n = 114) = .82, $p = .35$, N.S.] despite some loss of personnel from the originally constituted groups. These findings indicate that the performance differences obtained on either system over the two day period were not due to the influence of either GT or rank.

Soldier Characteristics and Identification Performance on First Day of Training

Performance scores of the groups trained on the two systems differed significantly on the first day of training. Separate ANOVAs were performed on those data. Rank and age as performance determinants were examined. It was found that age was not significantly related to performance. Rank proved to be positively correlated to performance on both systems (filmstrip $r = .36$, $p < .001$; slide $r = .31$, $p < .001$). Thus, it appears that whatever individual characteristics underlie the process by which a soldier earns promotion (or chooses to remain in service) also facilitates target identification performance.

Findings from previous research (e.g., Shope, et al, 1986;[47], Smith, et al,(In Press);[48] Smith, et al, 1984[49]) have found a significant relationship between GT and identification performance. GT categories were significant predictors of performance on the slides presentation, but not on the filmstrip presentation. Occurrence of generally high performance scores would contribute to a "ceiling effect" which in turn could preclude detection of performance differences among the GT categories.

Soldier Ratings of Each System

Each individual responded to an 11-item attitudinal questionnaire. The soldiers preferred the slide program in two categories: (1) it was easy to update or change and (2) a live instructor is the best way to train vehicle R&I.

In nine different categories the filmstrip was preferred over the slide program. When asked what system they preferred when giving or receiving instruction, the audio filmstrip was the preferred choice.

Discussion and Conclusions

The investigators had expected that there would be no significant differences in vehicle identification performance between the training systems. Soldiers trained on the first day with the slide system performed significantly worse than those who were trained with the filmstrip on the first day. Furthermore, soldiers who trained on the slide system on the second day performed no better than they did on the first day when trained with the filmstrip system. In addition, there was no significant difference between the filmstrip scores of the two groups in the research. This performance data for the first day of slide training was comparable to that found in earlier research. Thus, the significant difference between performance on filmstrip on day one and slides on day one would appear to reflect a reliable difference.

While the performance differences between media are reliable, the explanation for these differences is purely speculative. One interpretation of the performance differences is that the filmstrip system, with a taped narration, provided a more engaging activity than did the slide system with the narrative read aloud by an instructor. Thus, the soldiers might well have been more highly motivated to produce optimum performance. It should be noted that both "live instructors" had extensive experience in giving military instruction, and although no instructor ratings were obtained, they were considered to be "good" instructors. Smith, et al (1984)[50] found that when soldiers were trained with slides, Bessler Cue See and videotapes, no significant performance score differences were found. A recent survey of the literature (Babbitt & Nystrom, 1985)[51] indicates that situational factors may influence performance. The soldiers in this research rated the filmstrip as being preferred over the slide system, so it appears that motivational factors may account for the observed differences in performance.

The conclusions were:

- The Audio Filmstrip System trained combat arms soldiers to significantly higher combat vehicle identification performance after one training period than did the Slide System.
- The Audio Filmstrip System was evaluated as "significantly easier to use and maintain than the Slide System."
- The junior enlisted soldiers reported that they would prefer to receive future training with the filmstrip system and NCOs reported they would prefer to give future training with the filmstrip system.

Retention and Effects of Retraining

Background

Results obtained in the research by Smith, et al (1980)[52] indicated a significant improvement in performance in recognition and identification following CVI training. However, little was known about the effects of decay and retraining on R&I skills. Retention and retraining research in the Army was historically difficult to accomplish: many soldiers stay in the Army for only two or three years; their military training is usually short and once completed they are assigned to stations world-wide; the turbulence in units makes it very difficult to monitor performance over extended periods; it takes a sustained effort of military manpower and research personnel to conduct such experimentation, making it costly to conduct. Despite these factors, the Army proponent for R&I indicated to the research team that it was of practical interest to address three issues: (a) how rapidly do acquired R&I skills decay when not being used, (b) how do individual characteristics affect the decay and retention of R&I skills, and (c) what is the effect of retraining on skill recovery?

Method

To answer the questions posed by the proponent, Heuckeroth, et al (In press)[53] requested that soldiers ($n = 180$ males) from combat arms units at Fort Hood, Texas, be tasked for this research. It was requested that 60 soldiers be assigned to each of three GT categories: (1) $\leq$ 89, (2) 90 to 109, and (3) $\geq$ 110. It was further stipulated that these 180 soldiers be able to participate at three and six week intervals over a 13-week period. To increase the likelihood that soldiers would return, each battalion commander and his S-3 from the 12 units supporting the research were given a desk-side briefing on the importance of the research project. In addition, a military research coordinator from each of the two armored divisions established points of contact (POC) in each company. The research coordinator personally checked the roster at each training session so that he could call the POCs in each unit if their soldiers did not appear. Because the research involved longitudinal data collection, this strenuous effort was made to reduce the loss of soldier participation. In spite of the additional emphasis it was clear after the first week of the research that the sample would suffer unavoidable attrition as the data collection progressed.

The 180 soldiers were divided into four groups of 45 soldiers each, matched on GT levels. The training schedule was organized in the following manner. One group, the control group, received no training, but was tested at three week intervals throughout the research. All remaining groups were tested before and after training. One group was trained only once but participated in testing sessions at three week intervals. The two remaining groups received two training periods--one group at three weeks and the other group at six weeks after original training. All groups were again tested nine weeks after the original training. As to the training itself, the soldiers were trained over a period of three days, two training modules per day. On the third day they were administered the CVI Final Test after completing the last two training modules. Soldiers were given training on all 30 of the combat vehicles in the Basic CVI.

Data analysis

Soldier responses to the CVI Final Test (Module 7) provided the basis for defining a set of dependent variables for analysis. Among the measures were:

- Recognition score (front and oblique views--slides correct).
- Identification score (front and oblique views--slides correct).
- Number of vehicles correctly recognized.
- Number of vehicles correctly identified.

The first two measures were defined as the proportion of 60 slides in the Final Test to which a correct response was made; the latter two measures were defined as the number of times at least one of the two slides for each vehicle (front and oblique view) yielded a correct response. It was well understood that these measures were correlated--indeed it would be surprising were this not the case. The use of correlated measures in separate analyses has been motivated by questions raised by the R&I community. Neither type of measure seemed inherently superior although "number of vehicles" by type measures have conceptually greater meaning to many members of the R&I community. Measures based on number of slides provide more sensitive measures of program effectiveness and made possible comparison of present findings with results presented in earlier reports.

Results

Retention Performance

Examination of performance three, six, and nine weeks after an original training period indicated that the greatest decay occured sometime within the three week period immediately following training. Thereafter, decay was minimal (or nonexistent) for up to nine weeks. Decay following a second training period showed a similar trend. Based on these results, if performance levels reflected three weeks after training are acceptable, retraining is not recommended until at least the ninth week. No extrapolation beyond this time was possible, based on the research results.

Alternative strategies for training were recommended by the authors which might improve long term retention include:

- Training soldiers until performance reaches a specified criterion. The criterion selected depends on cost-effectiveness considerations associated with time to train to a criterion and the resulting retention curves.

* Retraining soldiers less than three weeks after original training was completed. Cost-effectiveness concerns associated with training time, meeting other training requirements and resulting retention curves must be considered.

Retention Performance and Background Factors

Results indicated that soldiers with different characteristics will attain different performance levels given a fixed amount of training. Overall identification performance levels attained were higher for soldiers who had higher GT scores. No significant relationship was found between rank or use/non use of glasses and identification performance levels. Soldiers with armor MOSs did somewhat better than those with artillery and infantry MOSs. A major question in this research was whether soldiers with different background characteristics would show differential retention performance as the time since training increased. On the average, those who performed poorly initially showed the same pattern of retention performance as did those who initially performed well. Depending on their characteristics, some soldiers will require more training to attain a specific level of performance; however, once that level has been attained, performance generally decays at about the same rate for all.

Effects of Retraining

In this research, two groups of soldiers were used to evaluate the effects of retraining. One group was retrained three weeks after the first training; a second group was retrained six weeks after the original training. In comparing pretraining and posttraining test scores, overall analyses indicated significant performance improvement occurred as a result of each training period. Further, performance at the end of the second training period was higher than at the end of original training. On the average, improvements in identification performance are about equal with each training period; recognition performance, however, improves most during the first training period.

Discussion and Conclusions

In R&I training it seemed that the most important concern was to devise a training strategy which optimized the speed of learning and maximized retention over time. With measures of performance surrounding only two training periods, formulation of a recommended training strategy is necessarily tentative. If we assume that the nearly identical pretraining to posttraining test improvements obtained in identification performance surrounding each of the two training periods (separated by at least three weeks) will be the same for subsequently equally spaced training periods, an extrapolation of these findings would permit an inference that eight or nine such training periods would be required before soldiers could correctly identify 80% of the vehicle images presented--for a total of 48.

It was concluded that in order to formulate more meaningful R&I training which is cost-effective, the Army must: a) establish criteria for acceptable R&I performance; b) determine optimal training strategies to achieve performance at that level; and c) make an assessment to determine for whom the required training would not be cost-effective (if any).

Effects of Verbal Ability and Morale on R&I Performance

Background

Previous research with training programs in the CVI series found that GT scores and other personal characteristics were correlated with R&I performance. It was hypothesized that the performance differences related to these characteristics were not a function of basic aptitudes, but rather were due to differences in actual background that resulted in differences in ability with the English language. It was further hypothesized that individual morale, whether specifically a function of these characteristics or not, might be related to R&I training performance. Based on these hypotheses, it was determined that research was needed to identify those environmental or background factors affecting performance that might be addressed through training program improvements.

Method

Measures believed to be related to task-specific verbal proficiency, general morale, and other soldier descriptive variables, were examined by Shope, et al (unpublished raw data)[54] as predictors of performance with the Basic CVI Training Program. The work was based on the belief that performance with verbally oriented training programs such as the CVI training program series may be closely related to task-specific verbal ability. A measure of this ability was obtained before the training with a short questionnaire designed for this research. A subjective self-report measure of both task-specific and general verbal ability was also obtained prior to training. An assessment of general morale was obtained by use of selected items from a previously developed questionnaire, the Commander's Unit Analysis Profile (CUAP) (Palmer, et al, 1984).[55] Soldiers were then trained on the Basic CVI in the prescribed manner after being pretested on their existing knowledge of the vehicles involved. The same test was employed as a posttest and was administered at the completion of training to assess the effectiveness of the training. The dependent measure used was the number of correct identification responses on the posttest. A final questionnaire was administered to obtain soldiers' evaluations of the training.

The research took place at Fort Clayton, Republic of Panama, using 129 male soldiers from the 193d Infantry Brigade. This unit was selected because it had a proportionately larger Hispanic population and, therefore, provided a basis for a closer examination of the relationship between English verbal proficiency and the performance on the Basic CVI Training Program. The Army-wide proportion of Hispanics reported by the Deputy Chief of Staff for Personnel was 4.4% (Department of Defense, 1981); the sample in this research had 21%.

Measurement Instruments

Final test (CVI). The Final Test module from the Basic CVI was used to measure the soldier's ability to recognize and identify combat vehicles. The test was taken both before and after the training.

Pretest questionnaire. Personnel were asked to evaluate how well they understood spoken English, how well they spoke English, and how well they read English. They were also asked how many hours of previous training in vehicle identification they had and whether they already knew the names of the parts of armored vehicles. Then, in particular, they were asked if they understood the names of vehicle parts when spoken, and whether they could say the names for these parts in English.

Verbal cue recognition (VCR) test. The VCR Test was administered to determine whether military vocabulary deficiencies might contribute significantly to lower R&I performance. During the test the soldier was presented with line drawings, one at a time, of 15 vehicles from the Basic CVI program. On each vehicle five parts or attachments were enclosed in a shaded and numbered rectangle. Below the drawing were numbers 1 to 5. An audio tape was played on which an instructor enunciated the name of one of the parts in the rectangle such as bore evacuator, muzzle break, sagger, etc. The soldier was required to circle the number below the figure that corresponded to the part. The names were taken from the script used in the Basic CVI Training Program. The odd/even split half reliability for the VCR was [r ($n=129$) = .67, p <.001].

Training readiness questionnaire (TRQ). The TRQ is made up of 34 items from the Commander's Unit Analysis Profile (CUAP). The CUAP was developed by the U.S. Army Research Institute (Palmer et al., 1984)[56] to provide commanders of company size units a means of identifying current troop attitudes that may detract from or contribute to overall operational effectiveness. The items were selected because of their face validity, i.e., they asked about individual attitudes toward conditions in their unit which may be correlated with performance in a clearly defined learning event. In this research the intent was to use the TRQ to predict R&I performance. The odd/even split half reliability of the TRQ was [r ($n=129$) = .84, p <.001].

Posttest training evaluation questionnaire. This questionnaire assessed soldiers' perceptions of the training in general. Items were concerned with how well they could see the cues, how well they understood the words, how well they knew the parts of armored vehicles, what they thought of the speed of presentation, how they thought the training compared with other training they had received, and what they thought of the instructions.

Procedure

Soldiers were trained in four groups in four different locations in the Republic of Panama. Two groups were trained in the morning and two in the afternoon. Each training session lasted for approximatley one hour and a half, Monday through Friday. The pretest measures were administered on Monday, with training on vehicle identification Tuesday through Thursday. The Final Test and Training Evaluation Questionnaire were administered on Friday.

Analysis

The dependent variable chosen to evaluate performance with the Basic CVI Training Program was the identification response. Previous research (Heuckeroth, et al, 1985;[57] Shope, et al, 1984[58]) has demonstrated this to be a reliable measure. The recognition response was relatively unreliable because it provided a 0.5 probability of being correct when soldiers were merely guessing, whereas the guessing factor with the identification response was nil.

Examination of the distribution of pretest identification scores revealed that over half scored "zero." However, when a one-way analysis of variance of the pretest scores across groups of a particular independent variable did attain significance, an analysis of covariance was used to examine posttest identification scores with the pretest identification score as the covariate.

Results

Unit Comparisons

No differences for either pretest or posttest identification scores were found among the four units. Contingency tables were constructed to allow comparison of the four units on the distribution of GT scores, Verbal Cue Recognition scores and Ethnicity groupings. The chi-squares compared indicated no significant differences among the units on the distribution of these variables.

Training Readiness

A stepwise multiple regression analysis was used to assess which, if any, of the 34 questions were significant predictors of the observed performance with the CVI Training Program. Four questions made significant contributions to predicting performance:

1. Is the promotion policy in your unit fair to "non-minority" soldiers?

2. In what condition are the tools, equipment, or supplies you usually work with?

3. Are you made to work unnecessary extra hours?

4. Do you get enough to eat when you are in the field?

Soldiers performed better with the CVI Training Program if they found the promotion policy for non-minority soldiers fair; the tools, equipment or supplies in good condition; were seldom made to work unnecessary extra hours; and got enough to eat when they were in the field.

Verbal Cue Responses

Scores on the Verbal Cue Recognition (VCR) test were used to divide soldiers into four groups with approximately equal n's. An analysis of variance was applied to the number of correct identification responses made on the pretest. Results showed a difference in performance with correct identification scores [F (3,125) = 15.7, p <.0001], indicating that performance improved as VCR scores increased. The comparison of posttest scores among VCR groups used an analysis of covariance model, with pretest scores as the covariate, to compare identification dependent variables. Results indicated identification scores on the posttest increased as soldiers' VCR scores increased [F (3,124) = 19.7, p <.0001]

Pretraining Responses

Frequency distributions of the responses to the pretest questionnaire revealed that most soldiers thought they commanded the English language "very well" or "well." They were somewhat more likely to respond "borderline" when asked if they could use this English in conjunction with the names of parts of armored vehicles. The soldiers were more normally distributed in response to questions as to whether or not they knew the part names of armored vehicles. The responses to the pretest questionnaire were also used as predictors of performance in a multiple regression procedure. Examination of the regression model indicated that the more names of the parts of the armored vehicles the soldiers knew and the more they knew them in English, the more likely they were to perform well with the Basic CVI Training Program.

Posttraining Responses

A multiple regression procedure was used to examine the relationship between performance and responses to the posttest questionnaire. The regression model suggested that the better soldiers knew the names of the vehicle parts used as cues, the better they performed on the Basic CVI program. The findings supported the hypotheses that culturally based differences in verbal ability with the English language were correlated with learning ability in the CVI program.

Performance on the CVI

A paired-comparison t test of correct identification responses between the pre- and posttest scores indicated significant improvement for correct identification responses with a pretest mean of 1.27 and a posttest mean of 8.42, t (128) = 11.71, p <.001. Note that this was out of a possible score of 60 correct identifications. These findings agree with previous evaluations of the Basic CVI (Smith et al., 1980;[59] Heuckeroth et al., 1985[60]).

Discussion and Conclusions

This research indicated that the verbal proficiency that soldiers bring to the training has an impact on their success with the training program, as does their morale and general aptitude as reflected by their GT scores. However, while aptitudes are more difficult, if not impossible, to influence, verbal proficiency is amenable to training, and morale is also subject to change.

The Verbal Cue Recognition test proved to be correlated with identification performance. The CVI program relies heavily on both visual and auditory components.

The difference between the lower scoring VCR soldiers and the higher scoring soldiers is related to their ability to understand the verbal cues ($\underline{M}$ = 15.25 compared to $\underline{M}$ = 4.26). The lower scoring VCR group scored barely above chance on the CVI Final Test after training.

How well the soldiers knew the names of parts of armored vehicles was not highly correlated with performance, but whether they could understand the names of parts when spoken in English, and whether they reported that they could say the names of vehicle parts in English were reliably and positively related to performance.

The extent to which soldiers declared themselves able to deal with conversational English had no impact on their training performance. Abilities with conversational English are certainly somewhat removed from English abilities with the names of parts of armored vehicles.

Combat vehicle identification training involves a specialized vocabulary not contained in everyday language. Many soldiers seemingly proficient in English may be pushed beyond their English-speaking abilities when confronted with such words as "bore evacuator" or "cupola." This was demonstrated by the fact that the VCR test was more strongly related to performance on the Basic CVI Training Program among those measures studied. It was not just a verbal proficiency measure, but specifically measured the precise verbal skills that would be needed to perform well with this training program--the skills necessary to identify those parts of a depiction of an armored vehicle.

This again points out that spoken language is an important component of such a classroom training program. Language deficiencies impair performance with any verbally oriented training program. Everyday conversational proficiency may not be sufficient; it may be necessary to incorporate the vocabulary peculiar to the training area into a training program. Most military training areas have words seldom encountered in everyday conversation.

Morale was also positively related to performance with Basic CVI training. A positive climate appeared to have a strong relationship with good performance on a CVI Training Program.

Verbal proficiency, particularly as measured by the vocabulary specific to the training task at hand, greatly increases the likelihood of success with the Basic CVI Training Program. It was recommended that training personnel place emphasis on the particular set of specialized words used in the area of training. Time spent familiarizing marginally English proficient soldiers with novel words to be used in a training effort should have a payoff.

Evaluation of the Unit Conduct of Fire Trainer (U-COFT)

Background

The Unit Conduct of Fire Trainer (U-COFT) is a tank crew simulator which was developed to train personnel on gunnery skills such as target detection, recognition, weapons/ammunition selection, aiming and firing. Only the tank commander and gunner undergo training in the U-COFT. The test of the U-COFT had as its objective (Lyons, 1982)[61] to determine the degree of improvement in the ability to not only recognize but also identify targets for individuals trained on the U-COFT (U-COFT Test Group) as compared with those individuals trained by the unit's current methods (baseline company).* Tank commanders and gunners from an armor battalion equipped with the M1 tank participated in the research.

Method

Pretest and posttest recognition and identification performance of participating tank commanders and gunners were obtained in groups of four individuals each. Color slides (35mm) were displayed for five seconds each, with the screen image size and viewing distance adjusted to simulate targets seen through ten power (10X) optics (such as those in the M1 tank) from a distance of 1750 meters. The control instrumentation changed the slides every five seconds with a "rollover" time of five seconds between each slide. The setup also recorded the time taken for each participant's first "friend" or "foe" response to the nearest 1/100th of a second, measured from the slide change impulse. Responses were input by means of two pushbutton switches ("friend" and "foe") at each of the four crew stations. All functions and response data were controlled and recorded by ADP equipment located in a van adjacent to the classroom used for the test. Imagery used in the test consisted of front, left side, right side, left oblique, and right oblique views of the T-72 tank, BMP troop carrier, GAZ 69 utility truck, M1 tank, M113 personnel carrier, and M38 utility truck. These were the only vehicles currently simulated by the U-COFT computer generated imagery. Ninety slides of these vehicles, distributed at random, were used for both pre- and posttest which required the soldiers to make a written recognition (Friend/Threat) or identification (name or number) response to each slide. There was no change in order of presentation.

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*The training method used by the unit was one of its own construction. It was not the Basic CVI Training Program (GTA 17-2-9)

Questionnaires were administered to instructors, tank commanders, gunners, and all data collectors participating in the U-COFT test in order to obtain their subjective evaluations of the device.

Results

The pretest results allowed little room for improvements. The mean percents correct for the U-COFT test group and the baseline company using recognition scores were 92.4% and 89.5%, respectively. There were no statistically significant differences in the pretest scores between the U-COFT test group and the baseline company, either in their ability to differentiate friend from foe, or in the average length of time they took to do so. The identification performance measure was not useful because the number of vehicles (six) were quickly learned resulting in a "ceiling effect" in the learning process. Comparison of pretest/posttest results, and comparison of the U-COFT group with the baseline company provided no basis for evaluation of the U-COFT as a training device for combat vehicle recognition and identification.

Discussion and Conclusions

With any gunnery simulator, the task of vehicle or aircraft recognition and identification is likely to be present even if it is ill designed. Using only U.S. vehicles or those of allied nations is not uncommon. The individual or crew being trained is typically taught to engage any target and not to discriminate friend from threat. Hence, they actually simulate fire against friendly targets. Until recently, live firing in the field followed the same procedures as those on the simulators as all targets were designated as threats. The newer firing ranges mix targets, requiring the crews to identify the target as a hostile or friendly target. The significance of the U-COFT evaluation was that it attempted to measure recognition and identification performance as part of the mission performance.

With the recent strong emphasis on the development of combat mission simulators which require embedded training, the question of image fidelity necessary for vehicle identification is becoming a paramount issue in stipulating requirements for such systems. Some of the respondents to the questionnaire in this evaluation apparently were not impressed with the imagery for R&I training purposes. Twenty percent rated the U-COFT as "unsatisfactory" or "very unsatisfactory" for teaching target identification. Another 18 percent rated it as being "borderline."

Identification Performance as a Function of Number of Vehicles Trained, Training Frequency, and Soldier Trainability

Background

Vehicle recognition and identification are common skills required of all soldiers. To pass the Skill Qualification Test (SQT), a soldier must correctly recognize eight vehicles and identify seven out of 10 vehicles selected for the test from a total of 30 vehicles to be learned.[a] However, the time allocated to R&I training was seldom adequate to meet the soldiers' needs. As shown in earlier ARI research, soldiers typically average about 30 percent correct identifications following one complete training cycle with the six modules of the Basic CVI. In addition, ARI research has shown that R&I skills decay rapidly following initial training. Therefore, at least for the present, it appears that the individual soldier preparing for the SQT must, of necessity, provide additional self-training on his/her own time.

Because of the premium placed on training time and because of the Army-wide requirement for R&I skills, it behooves the Army to get the maximum training benefit from the R&I training time available. To do this, trainers must make the most effective use of the Basic CVI.

In this first effort aimed at determining the most effective utilization of the CVI program, Smith et al (In press)[62] had two major objectives:

- To examine performance changes as a function of training time and number of vehicles trained.

- To examine whether all soldiers can be expected to benefit about equally from repeated training.

Method

Three groups composed of 27, 26, and 25 soldiers each, matched on GT scores, were given repeated training on varying numbers of vehicles taken from the Basic CVI Training Program (GTA 17-2-9). One group was trained on 2 modules of 5 vehicles each (10), a second on 3 modules (15), and a third on 4 modules (20). The training took place on each of three days. The training required, on the average, 25 minutes to train each module of 5 vehicles. The 4 module group received 4 repetitions during the three days (total of 6.7 training hours) while the 2 and 3 module groups received six repetitions (5 hours and 6.7 training hours respectively). An initial pretraining test was given followed by posttraining tests administered at the completion of each training repetition. The tests consisted of having the soldiers identify projected slides of each vehicle. Three views (front, oblique, side) of each vehicle were randomly presented.

Earlier research with the CVI program (Shope, et al., unpublished raw data[63]) demonstrated a significant relationship between recognition and identification (R&I) performance and specific vehicle parts vocabulary. A test [the Verbal Cue Recognition (VCR) test used by Shope] was administered in this research before the pretraining test. Comparison of the VCR scores for these three groups showed a lack of balance; hence, a sample of 15 soldiers was drawn from each group so that those groups were now balanced (matched) on both GT and VCR test scores.

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[a] Field Manual No. 21-2. Soldier's Manual of Common Tasks Skill Level 1, October 1983

Data from four training trials was used. Test performance of the three matched samples of 15 soldiers produced the following results. The 10 vehicle group required 200 minutes and identified 84% of the 30 slides, or an average of 7.5 slides per hour of instruction. The 15 vehicle group required 300 minutes and identified 65% of the 45 slides, or an average of 5.8 slides per hour of instruction. The 20 vehicle group required 400 minutes and identified 69% of the 60 slides, or an average of 6.2 slides per hour of instruction.

The initial sample group of 78 soldiers was divided into "low" and "high" achievers based on their relative performance on the first posttraining test. In each of three vehicle groups, the mean percent of slides identified by the "high" achievers on their first repetition was not yet reached by the "low" achievers after four training repetitions.

Results

- Although additional research is required to conclusively establish the effects of overlearning on retention of this type of material, training of no more than 10 different vehicles per training session is more effective than training that addresses more than 10 vehicles per session.

- Some soldiers have extreme difficulty learning to recognize and identify vehicles even after lengthy training. Consideration should be given to the use of a selective procedure, such as using test scores following a single training session on the Basic CVI Training Program (GTA 17-2-9), to determine who should receive additional R&I training.

Discussion and Conclusions

Although additional research is required to examine the effects of overlearning on retention of this type of material, the findings suggest that two modules (10 vehicles) is the optimum number to use in training. The two-module group averaged 8.0 minutes of training for each correct identification, while the three-module and four-module groups averaged approximately 10 minutes each. While these time differences may be of little practical significance, the percent correct identifications for the two-module group was significantly higher than for the other two groups.

Consideration should be given to the use of posttest scores following a single training repetition as a selection device to determine who should receive additional R&I training. The time and effort required to train the low achievers to an acceptable level for combat may well be beyond the resources of any unit. At worst, scores on the first posttest should provide trainers with an estimate of who will require additional training and how much is likely to be needed.

Chapter 4

RESEARCH ON RECOGNITION AND IDENTIFICATION TRAINING WITH THERMAL IMAGERY

The Vietnam war provided the impetus for many technological breakthroughs which resulted in the development of a multitude of new night vision devices. The 24-hour battle day became a reality. Devices such as image intensifiers and passive thermal sights greatly increased the probability that hostilities in the hours of darkness would be just as intense as in the daylight hours. Of the many different types of night viewing devices, the one that showed the most promise from the outset was the infrared (IR) thermal sight. With this type of device the problem of target detection for combat vehicles no longer exists. If the vehicle has been running, its thermal signature makes it easily detectable. Although the thermal sight was developed for night use, it rapidly gained acceptance for day use due to its capability of penetrating obscurants such as smoke, fog, and dust. The thermal sight actually revolutionized armor warfare. It became possible to <u>detect</u> and engage targets with confidence at ranges near the maximum capability of the tank gun. The reliance on this sight, both day and night, places an additional training burden on our Army. Our soldiers must not only learn to engage with thermal sights, but must also first learn to recognize and identify potential targets to insure that only hostile targets are engaged. The pressing need for thermal R&I skills has been brought into sharp focus recently by the unexpectedly large number of friend-on-friend engagements experienced by the Israelis and by our troops at the National Training Center (NTC). The need for R&I skills has now been recognized by some officers at the highest levels of the Army. An example was the request during the late spring of 1985 by the Vice Chief of Staff of the Army for a review of the literature to establish the criteria for selection of personnel with greater capabilities of target detection and R&I as gunners for new weapon systems being developed.

Identification Performance With Black Hot and White Hot Thermal Images

Background

The interim thermal imagery R&I program developed by the research team employed simulated black hot imagery. (This program was described in Section 2 of this report.) The choice of black hot, rather than white hot, was based on two primary considerations. First, examination of imagery collected during three extensive imagery collection periods from which approximately 3000 through-sight photographs were obtained resulted in the conclusion that the black hot image retained its shape better at longer ranges due to less "blooming" of the image. Second, interviews with experienced sight operators indicated that the black hot image was generally preferred for identification purposes, particularly at longer ranges.

Although the subjective evidence favored the black hot image for R&I purposes, a search of the literature revealed no research comparing the two polarities. Therefore, efforts aimed at determining which type of imagery was superior for R&I, if either, and under what conditions, was warranted before any further development of training programs proceeded.

Method

Purpose

The purpose of this research conducted by Heuckeroth et al (1985)[64] was to provide the R&I and training communities with a preliminary evaluation of the relationship between range and polarity selection on vehicle identification performance with thermal images. The major objectives of this research were to determine: (1) how overall identification performance differs with slides of black hot and white hot thermal vehicle images, and (2) how identification performance is affected by black hot and white hot thermal sight settings at different ranges.

Procedure

A total of 100 soldiers from the 2d Armored Division at Fort Hood, Texas, participated over a four day period. Each soldier selected was a tank crew member or Bradley Infantry Fighting Vehicle (IFV) crew member with experience in the use of thermal sights.

On the first of four days participants were pretested for identification proficiency with one black hot and one white hot image for each of 12 vehicles at each range category (800-1200 meters, 1300-1700 meters, and 1800-2200 meters). The imagery employed consisted of photographs of single frames from video tapes which had been obtained earlier for another purpose. While changes in weather conditions caused some variability in the quality of the images obtained, every effort was made to obtain the best imagery possible for each range category. Paired black hot and white hot images were always from the same aspect angle. However, the aspect angles of the images for a given vehicle varied from one range category to another. Following the pretest, the participants were trained to identify black hot and white hot images of each of the 12 vehicles as seen at a range of 800-1200 meters. After approximately five hours of training, participants were given a posttraining test to evaluate the level of training attained. Training at the relatively close range, 800-1200 meters was designed to maximize the chances that participants would learn the thermal black hot and white hot image characteristics of each vehicle. It was reasoned that if the participants knew the signatures of these images, the performance exhibited at the same or other ranges a short time later would be primarily a function of their relative identification difficulty--and not a function of not learning the signatures. The posttest, like the pretest, included black and white hot images of each vehicle at each of the three range categories.

In order to assess performance differences relatively independent of the effects of learning differences, only participants who attained 80% or better correct identification on the posttraining test were included in subsequent analyses ($n = 34$).

Results

The results presented in this research addressed four issues: (1) How overall identification performance differed when using slides of black hot versus white hot thermal vehicle images; (2) How identification performance with black hot and white hot thermal image settings is affected by different ranges; (3) How overall identification performance using thermal images changes at different ranges; and (4) How identification performance differed with each vehicle, independently and in combination with image polarity setting and range.

Image Polarity Settings

Vehicle identification performance was superior with images taken with the black hot polarity setting [F (1,33) = .28, p <.0001].

Image Polarity Settings and Range

One major impetus for this research was the belief that at near ranges identification performance using black hot and white hot images would be about equal, but as range increased, black hot performance would be better than white hot performance. The posttest data did reveal significant performance differences of image type and range [F (2,66) = 11.51, p <.0001]; however, differences between polarity types was greater for near ranges but became smaller as image range increased. A separate analysis for image types at each range showed that only at the near ranges was performance with black hot images significantly superior to white hot images [F(1,33) = f57.64, p <.0001], although at all three ranges used, overall absolute performance differences favored black hot images.

Identification of Thermal Images at Different Ranges

Identification of thermal images depended largely on vehicle shape. It would be assumed, as range increases, the differentiating cues between vehicles would be expected to become more difficult to discern. The posttest analysis revealed significant performance differences as range increased [F (2,66) = 363.35, p <.0001]. A Duncan Multiple Range Test indicated that while performance monotonically decreased as range increased, only performance differences between the near range and the other two ranges (medium and far) were significantly different (p = .05).

Identification of Individual Vehicles

In an ANOVA, identification performance using thermal images showed significant differences in performance for different vehicles [F (11,363) = 92.58, p <.0001]. The analysis also indicated significant performance differences among vehicles presented with different image polarity settings (black hot/white hot) [F (11,363) = 15.42, p <.0001]. While overall it has been seen that performance on black hot images is higher, test results indicated that for five of the 12 vehicles, identification performance was slightly better with the white hot image. It appears that with increases in range, the better polarity for the identification of thermal vehicle images is dependent on the vehicle being observed.

Estimating Strength of Association

It is generally understood that statistical significance does not necessarily imply importance. In order to assess the relative importance of each of these effects, the $Omega^2$ statistic was used to estimate the proportion of variance in the identification performance which can be accounted for by those effects. It appears that the most important effects which contribute to variability in data came from effects involving vehicles (20%) and range (15%); differences in image polarity (3%), although producing large enough performance differences to be significant, accounted for such a small part of the variance as to be of limited practical importance.

Discussion and Conclusions

Contrary to expectations, the results indicated that although absolute performance differences favored black hot images over all ranges, it was only at the near (800-1200 meters) range that a significant difference was found. The results also indicated that all vehicles may not be easier to identify with black hot images. These findings suggest that while shape may be the primary cue used in identifying thermal images, some vehicles showed particular variations that were more easily discerned with the white hot image. These findings also suggest that once detection occurred in an environment calling for use of thermal imagery, the image polarity setting should initially be set to black hot to effect recognition and identification. Should R&I not be accomplished in a timely fashion with the black hot setting, the R&I task should be continued by adjusting the contrast and brightness settings until the specific differentiating features can be highlighted. If still unsuccessful, a switch to the white hot polarity should be made and followed with the adjustment procedure used with black hot. Further research would be of value to address which vehicles (and type) have characteristics that are revealed best with a high contrast black hot setting or a high intensity white hot image.

The factors of vehicle type and range, in this research were far more important than polarity. Range alone accounted for over 26% of the posttest identification performance variability. This finding that vehicle type is important is consistent with findings in earlier work (Smith et al, 1983,[65] Heuckeroth, et al, 1985[66]). Since cues available in thermal images are relatively few, it would be desirable to determine whether performance differences among vehicles might be reduced if some mnemonics were used for each vehicle. The current research also demonstrated that performance degradation with increased range was not uniform for all vehicles.

Development of Thermal Imagery for Recognition and Identification Training

Background

The development of imagery for both photopic and thermal image training programs was always a major undertaking in the TAATS work program. Sufficient imagery of the types needed proved to be unavailable. This was due in part to a lack of consistency in the ranges, vehicle aspect angles and backgrounds of the imagery available, and in part due to the virtual nonexistence of unclassified imagery for some modern threat vehicles. This was especially true for thermal imagery. Moreover, thermal images of many common NATO vehicles could not be obtained. This lack of useful imagery led the research team to conclude that simulation was necessary to produce training imagery for the vehicle types desired.

The highly detailed HO scale models and the realistic terrain board used for the Basic CVI were also used in developing the simulated imagery for the Thermal CVI Program. It was recognized that the simulated thermal imagery, while a satisfactory interim appropriate for the Thermal CVI program, could be improved upon and that a second generation program to eliminate these shortcomings was highly desirable. Therefore, a search for alternative means for producing training imagery and an evaluation of each was conducted.

Approaches to the Development of Thermal Imagery for R&I Training

Based on a search of the literature and contacts with the research community, Kubala (In prep)[67] listed four alternatives and described some advantages and disadvantages of each.

Real Thermal Imagery

The use of real thermal imagery would require through-the-sight photography of all vehicles.

Advantages.

- The obvious realism of the imagery could not be faulted.
- Acceptance by the military community as being the "real thing."

Disadvantages.

- Unavailability of comparable imagery (ranges and aspect angles) for all target vehicles desired.
- Presence of background-specific cues, unless imagery is manipulated.
- Original cost and update expenses are prohibitive.

Computer Generated Imagery

Computer generated imagery requires a programmer to build a three-dimensional "model" of each vehicle in the computer's memory based on thermal signatures obtained from photographs or other source material. The imagery is then either viewed on a CRT or photographed from the CRT and the training materials packaged in other media.

Advantages.

- The imagery can be manipulated electronically so that any aspect angle can be obtained easily and inexpensively.

- The vehicle image can be stripped from one scene and inserted into any type of background.

- It is possible to place the vehicles into motion.

- The operator can manipulate the imagery in much the same manner as operating a thermal sight.

Disadvantages.

- The only disadvantage of consequence is the initial cost. A cost estimate in 1982 placed costs from $9,000 to $15,000 per vehicle. A 1986 estimate from the same source indicated the costs would be higher. Software for manipulating the imagery had been much improved, but the programming process had changed little since 1982.

Through-Sight Image Projection*

This approach was originally developed by Electro-Optics and Infrared Measurements, Inc., under a subcontract to a Human Resources Research Organization (HumRRO) contract with the Army Research Institute. With this approach, a specially processed high resolution thermal image is projected into an actual thermal sight. An infrared emitter is used as the projection lamp rather than a high intensity white light. The projection system was referred to as a Thermal Target Projector (TTP) by the developer. The presumption is that the thermal sight will "see" the projected high resolution image in exactly the same way it would see the actual vehicle. Therefore, the image seen by the sight operator should be highly realistic.

Advantages.

- The imagery viewed through the actual thermal sight is highly realistic.
- Range can be easily simulated.
- The imagery developed could be projected into any thermal sight.

* In the summer of 1986, the research team assisted PM-TRADE, the proponent for Army Training Device Technology, in evaluating a demonstration model of the TTP. E-OIR was contracted by PM-Trade to develop and demonstrate a "low cost" infrared projector to be used in unit training for both recognition and identification and the operation of the thermal sight controls for imagery interpretation. The TTP demonstrated was an improved version of the original model developed for HumRRO. The primary objective of this evaluation was to determine whether the TTP-induced imagery appeared realistic to thermal sight operators experienced in looking at thermal sight imagery in operational settings. To accomplish this, gunners or tank commanders with a minimum of 36 months experience with thermal sights were requested for the evaluation. Subjective judgements of the simulated imagery provided the data for the evaluation. The primary findings were:

- Target images at simulated ranges up to 1200 meters were judged to be acceptable representations. There was less certainty about their quality for ranges beyond.
- The contrast and sensitivity settings employed by the gunners who performed better in the vehicle classification (Typing as truck, tank, APC, etc) and identification (naming the vehicles) tasks were generally higher than for those with poorer scores on these tasks. This finding was in keeping with expectations based on the research team's experience and predictions by technical experts in night vision.
- Since an actual sight is used, training in sight adjustment can be conducted.
- Any geographical background can be inserted relatively inexpensively.

Disadvantages.

The only major disadvantage is that the approach must first have high resolution thermal imagery of each vehicle at each desired aspect angle, which as pointed out previously, is very difficult and costly to obtain.

Video Simulation with Model Vehicles

This approach requires a special terrain board and vehicle models in a scale of 1:87 (HO) or 1:100. The desired thermal characteristics are then developed through painting the models and manipulating a series of spot or floodlights. A video camera is focused on the vehicles and the monitor controls are adjusted to further enhance the simulated imagery. It should be noted that other approaches to simulating thermal signatures by painting have been tried. However, none of the imagery examined appeared to be as realistic as that developed under the TAATS program.

Advantages.

- It is very inexpensive in terms of costs of materials.
- A wide range of thermal cues can be simulated.
- Imagery for any vehicle can be produced by simply building an accurate scale model.
- Different ranges can be simulated.

Disadvantages.

- A number of actual thermal images are required to determine the true thermal signatures of each vehicle.
- White hot simulations are less realistic than black hot.
- This method is labor intensive.

All of these approaches have some merit and all surely have disadvantages. Computer generated imagery is too expensive. Actual imagery for training will always be limited to a highly selective target array, composed of mainly friendly vehicles. A large number of unclassified thermal images was made available to the team from intelligence sources, but none was found suitable for training recognition and identification. The most promising approach to the simulation of thermal imagery appears to be within the utilization of models of video research and special effects technology.

Chapter 5

SELECTION AND TRAINING FOR R&I SKILLS

Literature Review for the Advanced Anti-Armor Weapons System-Medium

This research effort (Kubala, in press)[68] was a literature review which investigated the feasibility of selecting and training detection and identification skills for the advanced antitank weapons system-medium (AAWS-M) operators. However, if selection and training techniques prove successful, the methods could most likely be universally applied to any military weapons system which requires target detection and identification. The research addressed two questions, especially as they might be related to the AAWS-M. First, can personnel be selected for their ability to detect and identify potential ground targets and second, regardless of the answer to question 1, can detection and identification skills be improved through training?

Any work suggesting <u>other</u> aptitudes, abilities or personal characteristics that might be useful in selecting personnel for the operation of the man-portable AAWS-M were also noted.

<u>Background</u>

Over 21,000 individual documents were identified in the literature search as having information on either target detection, target recognition, target identification, target acquisition, target signatures, or some combination thereof. When additional qualifiers related to personal characteristics or training were added to the search strategy, the number of available documents dropped to only a few hundred. Approximately 300 documents were culled out and examined in enough detail to determine their relevancy.

The biggest problem with the reports lay in the incomplete reporting of personal characteristics. The attempt to determine the role of experience in target detection and identification performance was particularly frustrating. Neither the recency nor the relevancy of experience to the target acquisition task was reported, nor was the amount and recency of any relevant training. In addition, it was virtually impossible to compare studies to determine why inconsistent results were reported because of differences in factors which impinged on performance. Some of the differences among the research efforts are shown below:

- Targets

  Different: target objects
  target densities
  number of target types in array
  degrees of concealment
  exposure times
  Targets stationary or targets moving

- Geography

    Varied: terrain (from desert to forest)
            atmospheric/weather conditions or none reported

- Experimental Factors

    Different: definitions of detection and identification
               criteria of success
               observer locations (air/ground)

    Varied: observer aids (none, optical, electro-optical)
            degrees of briefing
            sizes of assigned search sectors
            conditions of early warning
    Observer moving or observer stationary

- Observers

    Varied: ages
            aptitudes
            visual characteristics
            occupational specialties
            experience
            levels of training
    Not reported

After a final review, a little more than 100 documents were found that bore directly on the questions that were asked. Most of these were concerned with air-to-ground target recognition and identification, some with ground-to-air, and some even with air-to-air. There appeared to be far less interest in ground-to-ground detection and identification. In selecting the final set of documents, the assumption was made that any personal characteristics which affected detection and identification performance in one situation would affect the performance in any similar situation.

Methods of Personnel Selection

Some of the things that were related to personnel selection were:

Criterion Reliability

Studies which kept track of individual performance over repeated measures were few, but fortunately, the findings were consistent. From these experiments, it was concluded that the personal ability to detect and identify targets was durable, in which case it should be possible to develop selection measures for this ability.

Paper-and-Pencil and Laboratory Tests

The results of these tests were not very encouraging. The Cattell test of 16 personality factors was used in two experiments by the British Airways Corporation (Seale, 1972[69]). This test, usually referred to as the 16-PF, is a well known and much used personality test. No relationships were found between detection performance and any of the 16 personality measures.

Measures of field dependence-independence were also tried. Presumably, measures of this trait evaluate an individual's ability to extract or find a particular figure embedded or hidden in a background of other figures. It would seem that high Field Independence scores should be predictive of target detection performance. However, the results with this kind of test were inconsistent. Nevertheless, since Field Independence scores were related to performance in some situations, some measure of this trait was recommended for inclusion in an experimental test battery.

Three studies dealt with selecting personnel for man-portable missile systems such as the Stinger and TOW (Stewart, et al. 1974;[70] Derhammer, et al., 1976;[71] and Miller, 1985[72]). A wide variety of paper-and-pencil and psychomotor measures were evaluated. The results were essentially negative. It was concluded that the prospect for using paper-and-pencil tests was not very promising.

Visual Tests

There are a multitude of visual tests; the problem was in finding the right tests. Most of the tests considered seemed to have little potential. Five of the tests were deemed to be noteworthy. Two of these, static visual acuity and color vision, are already in use by the Army in selection and classification, and should continue to be used. Three others, contrast sensitivity, dark focus, and peripheral vision are not in use.

(a) Static visual acuity. This is typically measured by the familiar Snellen type letter charts. There is ample research evidence that visual acuity is related to target detection and identification. However, further study of this measure is unlikely to be profitable. In an extensive review of the literature on air-to-ground target acquisition, Dan Jones, et al (1974)[73] cite 107 references dealing with visual acuity. However, the subject is dismissed in less than a page in the text--the reasons being that personnel performing target acquisition duties in the military were screened on the basis of static visual acuity, so the range of acuity was so small it was found to be of little practical importance in applied or field studies. Nevertheless it was recommended that personnel should still be screened to ensure that they have, or can be corrected to have, normal visual acuity, both near and far.

(b) Color vision. In a review of the literature on visual research conducted during World War II, it was concluded that color normals were superior to color defectives in detecting targets (Harvey, 1970[74]). No recent literature on this subject was located. It was concluded that AAWS-M gunners should be screened for normal color vision.

(c) Contrast sensitivity. A measure of visual performance not currently used by the Army that appears to have good potential is contrast sensitivity. Recent evidence suggests that it is actually a better measure of visual acuity than static acuity as measured by the Snellen charts (Ginsburg, 1980;[75] Ginsburg et al, 1982[76]). Kennedy, et al, (1984)[77] found that individuals with good contrast sensitivity did better at detection and recognition while performing tasks in flight simulators. Contrast sensitivity can be measured by several methods (Ginsburg, et al, 1983[78]). However, it is fairly time consuming and, depending on the methods employed, may require some special test administrator skills. There is also electronic equipment available for measuring dynamic contrast sensitivity. It was recommended that both static and dynamic contrast sensitivity be evalulated as selection measures because of the potential they appear to have for predicting target detection performance.

(d) Dark focus. An individual's dark focus is the distance at which the eyes focus when they have nothing to focus on, such as when in complete darkness. The eyes tend toward this resting state in periods of low illumination, such as at dusk. There are good indications that dark focus may be related to target detection (Kennedy, et al, 1984;[79] Owens, 1984;[80] Luria, 1980[81]). A limited experiment conducted by Kennedy, et al (1984)[82] found that dark focus was related to aircraft aspect recognition. If dark focus proves to be related to detection performance, gunners could be issued corrective lenses based on individual dark focus for use during periods of low illumination, thereby improving their detection capability. Dark focus, or dark accommodation, can be measured both quickly and inexpensively (Berbaum, et al, 1985[83]).

(e) Peripheral vision. There is very good evidence that peripheral vision is related to search performance (Smith, 1961;[84] Johnson, 1965;[85] Bloomfield & Smith, 1979[86]). Good peripheral acuity would seem especially important for detecting motion in the periphery. A major problem in testing for peripheral acuity is that the tests employed have typically shown fairly low test-retest reliabilities (Erickson and Burge, 1968;[87] Jones, Personal Communication, 1985[88]). For example, all four tests purported to measure peripheral acuity were discarded from the Naval Aeromedical Research Laboratory's Human Factors Vision Battery for this reason. A search should be made to find or develop some more reliable measures for peripheral vision. Assuming a suitable measure or measures could be found, it was recommended that peripheral vision tests be included in a visual battery to be evaluated.

Motivation

"Self-selection" is another approach that should be tried. Personnel who volunteer for a particular duty are more apt to be motivated than those who are levied into that particular duty. It was found that personnel selecting artillery as their branch of service were better performers than those who did not on most components of the forward area observers basic course (Mocharauk, et al, 1979[89]). In another study by Kubala and Christensen (1966),[90] it was found that volunteers for air defense training had lower attrition rates at all aptitude levels. Personnel who know what the job entails, and want that job, will likely do a better job.

One of the things that must be considered in evaluating the potential effectiveness of any selection program is the selection ratio. The larger the proportion of the total available pool of personnel that must be selected, the less effective selection will be, regardless of how highly the selection measures are related to the criterion.

Training for R&I Skills

The wide variety of situations in which target detection and identification training was evaluated makes it impossible to discern reasons why it was effective in some cases and not in others. There is ample evidence that it has improved detection and identification performance. The research accomplished by ARI in training photointerpreters demonstrated that training in systematic search increased detection (Powers, et al, 1973[91]). An early Human Resources Research Organization (HumRRO) study (Wolff, et al, 1962[92]) found that target detection training was most effective when a graded sequence of images was used. That is, when the detection task was gradually increased in difficulty. An area in the training domain that holds promise, but one which may require some research to develop, is the area of search strategy. Training in "how to" search was found to be effective in several studies.

All of the training studies reviewed which reported improvement following training, with the exception of one, appeared to have one thing in common. The training was developed following a relatively detailed analysis of the tasks to be performed. It was felt that the training for AAWS-M gunners must also be tailored to their specific needs.

In studies by Smith and co-workers at ARI-Fort Hood, in evaluating the CVI training programs, it was found that learning rates varied markedly among individuals. It was also noted that there would have been no way to separate the personnel on the basis of scores obtained prior to the first training session, as all pretest scores were very low. The ARI group at Fort Hood felt that a single training session could possibly be used as a selection device. Those personnel with an aptitude for target identification could be selected on the basis of a cutting score following the training and then further trained as AAWS-M gunners.

Discussion and Conclusions

Kubala found that some measures for selecting personnel held promise, but as yet have not been validated. The findings on the efficacy of training for target detection were mixed; training seemed to work in some situations but not in others. Overall, Kubala concluded that training will improve detection skills, but only if very carefully tailored to the job. The requirement for training in identification skills seemed obvious. If a soldier does not know what a Soviet T-72 tank looks like, he could not identify it even if he were standing next to it.

Finally, it was felt that there are some measures with good potential for selecting AAWS-M gunners. Based on the ever increasing cost of weaponry and training, it certainly seems worth looking into selection strategies to maximize weapon effectiveness on the complex battlefields of tomorrow.

Chapter 6

FACTORS AFFECTING IDENTIFICATION PERFORMANCE

Background

The requirements which governed the TAATS research covered in this document were promulgated by the representative of the user community, the Army's proponent for vehicle identification located at the Combined Arms Center, Fort Leavenworth, Kansas. The great need at the time, Circa 1980, was to develop, test and implement training programs on vehicle R&I as rapidly as possible because no standard programs or training criteria existed. In the course of satisfying these requirements, a number of factors which had a bearing on R&I performance in the ground-to-ground target acquisition process were considered. A review of literature on this subject done by Maxey et al (1976)[93] identified some of the major variables usually addressed. They were divided into two categories, stimulus and observer variables. It was judged useful to the reader to be able to quickly locate the research related to these factors rather than to search for them in the more detailed descriptions in previous sections. Hence, in this section, TAATS research findings that concerned these categories are catalogued and briefly described.

Stimulus Variables

The stimulus variables were further divided into target characteristics, environmental characteristics and task characteristics.

Target Characteristics

The major elements considered were size or shape, color contrast with background, brightness contrast, range (distance from observer), duration of exposure and presence of motion.

Size

The CVI training programs used 1:87 scale models throughout and achieved the effect of range by altering the distance of the viewer from the screen. These effects will be discussed under the topic of range.

Shape

The different shapes of combat vehicles can serve as means to distinguish one from another if the shapes are unique or they can serve to increase the confusion among vehicles if the shapes are similar. Heuckeroth et al (1985)[94] conducted preliminary research which demonstrated that a number of NATO vehicles were confused with WARSAW Pact vehicles especially the Saladin and BTR60, AMX30 and T62 or T72, and Scimitar and the T72. An exhaustive analysis was done that produced a weighted value estimate of the amount of confusion each of 25 NATO and WARSAW Pact vehicles had for each other. This research was intended as a starting point in defining the optimum training model by establishing the rate of which learning based on shape in order to determine frequency of training required for each vehicle. This work was overwhelmed by more immediate issues and remains a potentially interesting and valuable research area.

Color Contrast & Background

The work done by Haverland and Maxey (1978)[95] examined olive green painted vehicles against a homogeneous green background. Warnick et al (1979)[96] replicated their research and found, as they did, that at ranges of 3000 and 4000 meters R&I performance was not significantly affected. Warnick also used pattern painted vehicles against a textured background and found that R&I was not affected at ranges of 3000 and 4000 meters. These results led to the decision to use a standard pattern for the vehicles and photographed on a textured background. Holding these conditions constant controlled the tendency for soldiers to learn the peculiarities of the slide, i.e., background differences or vehicle irregularities, rather than the vehicle. Subsequent test experience with the training program has substantiated this fact.

Brightness Contrast

All models were photographed under standard lighting conditions so this variable was held constant.

Range

Haverland and Maxey (1978)[97] found no performance difference for R&I at simulated range of 3000 and 4000 meters. However, a significantly greater number of training trials was required to reach a criterion for 4000 meters. Heuckeroth et al (1985)[98] noted that R&I performance improved as range increased up to 3000 meters. Kottas et al (1980)[99] also found no performance differences at 2000 or 4000 meters. In other research by Smith et al (1984)[100] range comparisons using three media (video, 35mm slides and Bessler 8mm film), no R&I differences were found between 1500 and 2500 meters. Warnick and Kubala (1979)[101] noted no performance differences at scaled ranges up to 3000 meters. The only research that noted a significant difference between 1200 meters and 2000 meters was done by Kubala et al (1981).[102] However, the use of targets that were masked significantly reduced the available cues which may have accounted for their findings.

Duration of Exposure

All vehicles were exposed the same amount of time.

Motion

In the research by Smith et al (In press)[103] three types of motion were added to the vehicles. They found that motion had little or no effect on performance or short term retention. Moreover, when the sample was divided into "high" and "low" performers, performance did not benefit differentially from the use of motion. Additional factors were examined in the TAATS research not identified by Maxey et al (1976).[104] They were: 1) the amount of the target that must be exposed before a soldier could be expected to recognize or identify the it; and 2) the effect of aspect angle in the task difficulty.

Target Exposure

The extensive research by Kubala et al (1981),[105] used five levels of vehicle exposure. The greatest exposure was all of the vehicle from the axle or mid wheel and the least exposure was just below the gun tube. Scale models (1:87), ten in number, were photographed at each masking level in three views (one side, the opposite oblique and the front). Two ranges, 1200 and 2000 meters, were employed. The research served to determine how much of a vehicle could be masked before a soldier could R&I the vehicle and to determine what cues soldiers could use to reliably identify masked vehicles. Results showed that two levels of masking could be used, one which obscured the threat portion of the vehicle from just beneath the main weapon to the ground and a second, which obscured the chassis. The training program which utilized these findings, the Advance CVI Training Program, required significantly more soldier training to achieve satisfactory levels of performance.

Vehicle View or Aspect Angle

The position of the vehicle (target aspect angle) was consistently found to be related to R&I performance. Five views were usually used in the CVI Training Program series, the right and left oblique, right and left side and the front. Early research by Haverland and Maxey (1978)[106] found the front view to be significantly more difficult for R&I and the side views the easiest. In evaluation research of the Basic CVI Training Program, Smith et al (1980)[107] and Heuckeroth et al (1985)[108] findings were similar; the front view was significantly more difficult, and the oblique, while not significantly different, was somewhat more difficult than the side aspect angle.

Other research by Warnick et al (1979)[109] and Kottas and Bessemer (1980)[110] found the front view significantly harder to R&I.

Environmental Characteristics

The second major characteristic discussed by Maxey et al (1976)[111] was the effect of environment on R&I. This was noted in the research by Kubala et al (1981)[112] covered under the color and contrast paragraph. Here the background was varied from green to texture (simulating normal terrain). Neither background had a detrimental effect on R&I performance.

Task Characteristics

These were defined by Maxey as rules and procedures governing the conduct of the task such as observer movement, practice, search area, etc. None of these were manipulated in this research.

Observer Variables

The observer variables addressed in this TAATS research were rank, MOS, GT, and whether glasses were required to perform the R&I task.

Rank

In general rank would be presumed to be related to performance. Heuckeroth et al (1985)[113] found that privates generally had poor performance with a trend (though not significant) for performance to improve with rank. Research by Nicholson et al (1985)[114] in evaluating two media for the Basic CVI Training Program found that rank was significant on both media. Nicholson does not indicate what ranks were the best performers. Smith et al (In press)[115] found that where soldiers were separated into high and low performing groups, rank was unrelated to membership in the group. Heuckeroth et al (1984)[116] in research on retention found that identification performance increased with rank but recognition performance did not. In like manner Smith et al (1984),[117] in examination of the effects on performance of imagery projected through three different media, found that rank did not effect performance.

Military Occupational Speciality (MOS)

Soldiers in combat arms units with armor MOSs were found to perform better than soldiers with either infantry and artillery MOSs [Heuckeroth et al, (1984)[118]].

Use of Glasses

Soldiers who wore glasses performed as well as soldiers whose vision needed no correction [Smith et al (1980);[119] Smith et al (1984)[120]]. Heuckeroth et al (1985)[121] found that soldiers who wore glasses were significantly better at identification. This was interpreted to mean that many soldiers not wearing glasses needed correction.

General Technical (GT) Measure[a]

In most of the research, the GT measure was used as a rough approximation of the intellectual function level of the soldier. Smith et al (1984)[122] and Lyons et al (1982)[123] noted that soldiers with GT scores below 100 showed significantly poorer identification performance when compared with scores over 100. Using regression analysis, Shope et al (Unpublished raw data)[124] found GT to be highly correlated with performance. In comparison of identification performance on 35mm slides and film strip presentation of the Basic CVI Training Program, Nicholson et al (In press)[125] found GT to be significant predictor of performance on the slides but not on the filmstrip. Heuckeroth et al (In press)[126] found the GT was one of several factors related to retention of vehicle identification information.

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[a] GT is a score obtained from the Armed Services Vocational Aptitude Battery. It is a composite of scores from tests of verbal and arithmetic ability.

Verbal Cue Recognition (VCR) Test

Shope et al (Unpublished raw data)[127], using the VCR test, found that soldiers who performed well on the test also had higher identification performance scores on the Basic CVI Training Program. In additional analyses using VCR, GT, and a third rating scale that measured motivation, the Training Readiness Questionnaire (TRQ), in a multiple correlation model, the VCR test accounted for a larger part of the variance than either GT or TRQ.

Trainability

In work first done by Smith et al (In press)[128] to determine whether all soldiers benefited equally from repeated training, it was found that low overall performance means were a result of the consistently poor performance of about 25-30% of the soldiers. Follow-on research by Smith et al (In press)[129] using test scores obtained immediately after the first training session to divide the population into high and low achieving groups, found low achieving groups required four training trials to attain the same performance level as the high groups after only one training session. These findings raise questions about the desirability of training all soldiers in identification skills.

While the preceding material has dealt with the same material, the presentation has organized the research around the two most important variables in the R&I program, the stimulus and the observer. Through this "rehash" it is intended that the reader will more easily find the information that is sought.

Chapter 7

MANPRINT APPLICATIONS OF TAATS MASTER DATA BASE - RELATIONSHIP BETWEEN VEHICLE IDENTIFICATION PERFORMANCE AND ASVAB

The MANPRINT Connection

This research utilized eleven independent research projects conducted from 1980-1985 under TAATS involving soldiers stationed in units throughout the Continental United States (CONUS), U.S. Army in Europe (USAREUR) and the U.S. Army South (SOUTHCOM) were completed and reported. Performance measures from 942 soldiers were collected.

A renewed Army interest in 1986 in the man in the system called MANPRINT (Manpower Personnel Integration)[a] caused a redirection of the energies of ARIs System Research Laboratory (of which Fort Hood is a part).

The MANPRINT emphasis renewed the interest in understanding the relationship between soldier performance and aptitude. Objective measures of soldier performance became the sine qua non of research. A link between these performance measures and the Armed Services Vocational Aptitude Battery (ASVAB) was sought to determine how well the ASVAB selected personnel for various jobs based on their actual performance on the job.

The confluence of these two conditions--the availability of a large data base of objective performance measures and the advent of MANPRINT with its renewed emphasis on objective performance measures--led to the research project by Heuckeroth and Smith, 1986.[130] This chapter will present a summary of their research.

Method

Development of the Combat Vehicle Identification Master Data Base

A MASTER data base was created which contained data elements common to the various TAATS research efforts. Generally, these elements fall into three classes: 1) Background and demographic characteristics; 2) Performance--specifically number of photopic images correctly identified; and 3) Aptitude measures (ASVAB Scaled Scores and Subtests). The process involved in development of this data base as a Statistical Analysis Software (SAS) data set required examination of the individual data bases for thirteen coordinated research and development efforts in the TAATS program. Based on that review, only those performance data common to all eleven research efforts were included. For example, in some efforts the posttraining test involved exposure to two views of each vehicle while in other studies three and five were used. To increase the comparability of performance data, only the posttraining test

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[a] The MANPRINT idea includes attention not only to manpower, personnel and their integration but also training, human factors engineering, safety and health.

responses to images of vehicles in the two commonly presented views (front, left or right oblique) were used to define the identification performance (criterion) measure.

The authors pointed out that the task required of the soldier, i.e., identification of a vehicle, is relatively complex. Identification as defined throughout the TAATS research is naming or giving the number of the vehicle--for example, T-62, Bradley, or Leopard. Embodied in this response is the implicit knowledge that the vehicle is a "Friend" or "Threat" and that it falls into one of several classes of vehicles--for example, tank, armored personnel carrier or self-propelled gun. A substantial part of the task was cognitive in combination with simple rote learning and perception.

Obtaining the ASVAB Scores

Following development of the performance and background and demographic characteristics of the MASTER data base in the spring of 1986, ASVAB Composites and Subtest scores were obtained.[b] ASVAB Composite scores were standardized (scaled) scores while Subtest scores received were in raw score form. In order to provide a measure of standardization for Subtest scores based on different numbers of items, all Subtest scores were converted to percentages prior to any analyses. Tables 8 and 9 list the ASVAB Subtests found in different forms of this test and the particular Subtests used in defining each Composite measure.

Characteristics of Soldiers Included in the Master Data Base

While missing data did preclude use of all soldiers in all analyses, it is nevertheless relevant to provide generally descriptive data along several dimensions. These data speak to the relative heterogeneity of soldiers studied. Characteristics of the population described include: 1) Military Occupational Speciality (MOS); 2) Rank; 3) Racial and Ethnic Background; 4) Education; 5) Age; 6) Service Time; and 7) Time in MOS. In addition it is interesting to note that 22.8% (*n* = 211) of soldiers included in this data base used glasses on the job;[c] 11.1% (*n* = 100) used them for reading only.[d] Finally, the vast majority of soldiers were males (96.5%, *n* = 828).[e]

While Heuckeroth and Smith presented these population data, they did not analyze this data maintaining that it was generally beyond the scope of their research objectives to explore performance and aptitude relationships for particular soldier characteristics categories.

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[b] Composite scores are computed by combining two or more Subtest scores in various combinations. For purposes of this analysis, the Armed Forces Qualification Test (AFQT) is considered a composite.

[c] Data concerning use of glasses on job is missing for 16 soldiers.

[d] Data concerning use of glasses for reading is missing for 41 soldiers.

[e] Data on soldiers' sex missing for 84 cases.

Table 8

Subtests Used in ASVAB Test Forms 5-7 and ASVAB Test Forms 8-14

ASVAB Test Forms 5-7	ASVAB Test Forms 8-14
Armed Forces Qualification Test (AFQT) Subtest	
Word Knowledge (WK)	Word Knowledge (WK)
Arithmetic Reasoning (AR)	Arithmetic Reasoning (AR)
Space Perception (SP)	Paragraph Comprehension (PC)
	Numerical Operations (NO)
Other Subtests	
Numerical Operations (NO)	
General Information (GI)	
Electronics Information (EI)	General Science (GS)
Mathematical Knowledge (MK)	Electronics Information (EI)
Mechanical Comprehension (MC)	Mathematical Knowledge (MK)
Automotive Information (AI)	Mechanical Comprehension (MC)
Shop Information (SI)	Auto/Shop Information (AS)[a]
Attention-to-Detail (AD)	Coding Speed (CS)[b]
General Science (GS)	Verbal (VE)
Classification-Inventory Scales	
Mechanical (CM)[c]	
Attentiveness (CA)[c]	
Electronics (CE)[c]	
Outdoors (CC)[c]	

Table 9

Aptitude Area Composites Used in ASVAB Test Forms 5-7 and ASVAB Test Forms 8-14

Aptitude Area Composite	Subtest Used in Computing Composites	
	ASVAB Test Forms 5-7	ASVAB Test Forms 8-14
Combat (CO)	AR+SI+SP+AD+CC	AR+AS+MC+CS
Field Artillery (FA)	AR+GI+MK+EI+CA	AR+MK+MC+CS
Electronics (EL)	AR+EI+SI+MC+CE	AR+EI+MK+GS
Operators/Foods (OF)	GI+AI+CA	NO+VE[a]+MC+AS
Surveillance/Communications (SC)	AR+WK+MC+SP	NO+CS+VE+AS
Motor Maintenance (MM)	MK+EI+SI+AI+CM	NO+EI+MC+AS
General Maintenance (GM)	AR+GS+MC+AI	MK+EI+GS+AS
Clerical (CL)	AR+WK+AD+CA	NO+CS+VE
Skilled Technical (ST)	AR+MK+GSB	VE+MK+MC+GS
General Technical (GT)	AR+WK	VE+AR

Note 1: Raw subtest scores from ASVAB Test Forms 5-7 are used in computation of Composites.
Note 2: Composites for ASVAB test form 5 are as defined for ASVAB test forms 6 and 7 except that Subtests CA,CC, CE and CM were not used.
Note 3: Standard subtest scores from ASVAB Test Forms 8-14 are used in computation.
[a]Verbal (VE) is a standard score conversion of the sum of raw scores for word knowledge (WK) and paragraph comprehension (PC).tbl 1

Analysis

The research had two primary objectives: 1) to explore the relationship between vehicle identification performance and ASVAB Scaled Scores or Subtest scores and 2) to provide analyses which document the validity of the relationships obtained. In addressing these objectives, four analytic techniques were used: 1) Correlations of individual ASVAB Scaled Scores and Subtests with soldier vehicle identification performance, 2) multiple correlations between soldier vehicle identification performance and ASVAB Scaled Scores or Subttests as predictor variables, 3) correlations of differentially weighted scores of ASVAB predictor variables with vehicle identification performance, and 4) discriminant analyses.

In order to address the issue of validity of findings resulting from application of these analytic techniques for the entire set of data, those techniques were also used with random halves of the entire set. Comparison of results from analyses of random halves provided the basis on which validity was assessed.

Low correlations are sometimes found because the criterion itself is unreliable. This is usually a result of poorly defined measurements, use of overly subjective judgements, inadequately trained data collectors, uncalibrated equipment, or some combination of these factors. In order to assure that findings reported here were not attenuated by low reliability of criterion variable--identification performance--results of two consecutive post training tests with no intervening training were correlated yielding a retest reliability of .88.[f] Applying the correction for attenuation to the criterion described by Guilford produced negligible changes in correlations involving ASVAB Scaled Scores and Subtests with identification performance.[g] Consequently, correlations reported have not been corrected for the very slight unreliability they manifest.

Results

Individual Correlation Relationships

In the analyses reported, the intent was to explore in several ways the relationship between criterion variable (vehicle identification performance) and predictor variables (ASVAB Scaled and Subtest scores). Concern was focused not only upon the magnitude of the relationship but also upon the validity of findings reported. Within chance expectations, the obtained relationships were concluded as valid--whether ASVAB Scaled S e or Subtests were used with forms 5-7 or 8-14. For the correlations betwee iterion and individual predictors, values obtained indicated that, depending which predictor is used, between 1% and 13% of the variability between cri ion and predictors is in common. Obviously there is a great deal of criter n variability which must be

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[f] Myers, . Fundamentals of Experimental Design, Allyn & Bacon, Boston 1967, pp. 294-299.

[g] Guilford, J.P. Psychometric Methods, McGraw-Hill, Inc., New York, 1954, pp. 400-402.

accounted for by other factors. For ASVAB Scaled Scores, the range of obtained correlations is .212-.336; for ASVAB Subtests this range is .171-.358. It is further relevant to state the rather obvious fact that the utility of the ASVAB (as currently designed) as a predictor will vary for different criterion skills which define competency in different MOSs. The question asked should not be "Is the ASVAB a valid predictor of Army performance"? but rather, "For what Army performance is the ASVAB a valid predictor?" Beyond this point it is appropriate to conduct additional research aimed at identifying new ASVAB Composites which relate to other Army skills.

Multiple Correlation Relationships

When the stepwise regression procedure was used as a basis for selecting "optimum" multiple correlation relationships as opposed to an a priori model, the most general finding was that adding ASVAB predictors into linear combinations generally does not result in significant improvements in relationship between criterion and predictors over use of individual predictors.

Differential Weighting Correlations

In order to address the validity of the differentially weighted correlations, two procedures were used. First, differentially weighted correlations were obtained for random halves of the data for each ASVAB predictor. These correlations speak to the replicability of findings across independent samples. A second procedure involved using the weights estimated for each half to compute a correlation for the entire sample. As noted, for the Composites, no significant differences occurred; however, several were significantly different for ASVAB Subtest--more than might be expected by chance. It might be concluded that differentially weighted correlations are valid for Composites which are scaled scores but not Subtests which are percentages. It is not clear whether these conflicting findings can be attributed to differences in the type of variable used. Of the seven cases where differential weighting correlations for random halves do differ significantly, neither of the correlations for (or based on) random halves have a magnitude which is significantly greater than zero for five of these cases. It might be concluded that it is unreasonable to test for significant differences among two values which are in themselves not significant. For the remaining 35 comparisons, two show a significant difference. With alpha set at .05, approximately two such differences could be expected by chance.

Discriminant Analyses

Perhaps the most important finding of this research effort is the fact that soldiers can be assigned a priori to low and high vehicle identification achievement groups with about 75% accuracy using a quadratic discriminant function involving only ASVAB Scaled Scores. Were background and demographic variables also introduced into the discriminant analysis, additional achievement classification improvement might result. Again, the inclusion of demographic and background factors were generally beyond the scope of the present research effort. Discriminant functions might be best suited for use in guiding new soldiers into MOSs where combat vehicle identification is or is not an especially critical skill.

Discussion and Conclusions

Corrections based on equally weighted scores for individual ASVAB Scaled Scores and Subtests are in the high .20s and low .30s.

When ASVAB scores for individual Scaled Scores and Subtests are differentially weighted, modest increases (of about .05) in the absolute value of the correlations may be obtained.

Multiple correlations involving more than one ASVAB Scaled Score or Subtest are comparable to correlations obtained by the differential weighting of scores for individual ASVAB Scaled Scores and Subtest.

Soldiers who will score "high" or "low" in vehicle identification performance can be identified in advance about 77% of the time by using quadratic discriminant functions involving ASVAB Scaled Scores.

Supplementary analyses involving use of random sample halves generally confirm the validity of relationships reported.

Chapter 8

FUTURE RESEARCH NEEDS

Combat Vehicle Identification Data Base

One of the basic premises within the Army is that all soldiers must display a minimum level of skill in identifying combat vehicles and aircraft (low and high performance). Beyond that, soldiers in a number of duty positions or unit assignments need increased combat vehicle identification (CVI) skills to accomplish their missions. The increased requirements range from a limited knowledge of a few additional vehicles to in-depth knowledge of the vehicles and associated units of U.S., allied, and threat armies. Actual knowledge requirements will differ from duty position to duty position and in different geographical theaters of operations.

Several surveys have been undertaken in both our Army and the British Army to try and ascertain what vehicles and aircraft need to be included in an R&I training program. Needless to say, the target arrays have been fairly large and comprehensive. What is needed is a combat vehicle identification data base (CVI-DB) whereby any commander world-wide could tailor a program to his unit's individual needs. The data base would include <u>all</u> combat vehicles, and all low and high performance aircraft used by any military group anywhere in the world. The data base would be constantly updated as new vehicles are fielded. Once the commander inputs his target array requirements, the computer program would format the training material into training modules, accompanied by prepared scripts, tests and instructional material. The CVI-DB training system would utilize the basic concepts already formulated and tested by the TAATS research team. No longer would units need to be surveyed as to what their R&I requirements are. All the training materials would then be sent to the commander or training personnel responsible for the R&I training. The development of the CVI-DB system would place a commander's needs at his fingertips.

Interestingly, when the British became involved in the Falklands they approached the ARI TAATS research team as to the availability of an Argentinian R&I training module to help in training their military; unfortunately, nothing like it had been developed. A CVI-DB system would have been able to respond immediately to such a request.

Alternative Training Methodologies and Techniques for Conducting R&I Training

The methodology used by ARI to develop the CVI series of R&I training programs was based on field research utilizing personnel from the 6th Air Cavalry Brigade at Fort Hood, Texas. Extensive research with the CVI programs over the past 10 years has shown that the basic program design was a good one. The Basic CVI training program was used as the primary test instrument in a large number of research experiments. Each time the data have supported the fact that when soldiers are trained with the Basic CVI program, significant increases in R&I performance occur.

When the Basic CVI program was developed, due to the urgent demand throughout the Army, it was not possible to experiment with different training methods for teaching R&I. There is still a requirement to investigate other methods and techniques for presenting instruction of this kind. Training of visual identification skills still remains a time-consuming effort.

Use of Motion

The data from the target motion research indicated that with repeated training, rotational motion of vehicles results in an improvement that was statistically significant but of little practical significance. The British Army developed a prototype R&I program in which they incorporated what they termed "video rotation" for the target vehicles. The advantage of using video rotation is that the soldier sees the complete vehicle in a very short time as compared to other media such as 35mm slides or filmstrip formats. Motion also seems to be inherently motivating as compared to stationary imagery. The potential for training with this type of motion should be further investigated to validate or invalidate, as the case might be, the original findings.

Use of Range

The use of "zoom" imagery is another alternative which should be evaluated. In this type of presentation mode, the target is first presented at a long range, then the image size appears to grow larger and larger with consequent increases in detail. The use of "zoom" imagery may also provide range feedback information which may help in estimating range to a target.

Until the development of the Basic CVI program, almost all R&I programs in use throughout the Army taught soldiers to identify vehicles from highly detailed drawings or from photographs taken at very close ranges. Identifying features and characteristics learned and most often stressed during training were those which could be seen only at close ranges. Many of these cues were of little or no value at tactical ranges. U.S. forces must learn to identify vehicles at typical engagement ranges. This tendency to learn and try to use the easy cues has been called "overshadowing." The photographs employed in training were usually in black and white, and rarely showed the vehicle in tactical settings. On the battlefield, vehicles are most likely to be seen against a terrain background and may well be camouflaged. Two of the basic premises employed in developing the Basic CVI were that soldiers would be taught to recognize and identify vehicles at the tactical ranges they would normally first see them and should be taught only those cues which could be seen at those ranges. However, the Basic CVI is capable of simul. .ing any range from 500 meters to 4000 meters for a variety of optical device magnifications. Therefore, training would not have to be conducted only at the tactical ranges of the weapon's systems of the soldiers in a particular class.

Research is needed to determine whether training at near ranges followed by training at tactical ranges, or vice versa, might prove to be more time/cost effective in the long run than the present approach with the CVI program.

Use of Comparison Training

In the Basic CVI program, the test scores for the training modules (five vehicles) are typically high, with a large percentage of soldiers scoring 100% identifications on each module test. However, identification scores on the final test (30 vehicles) typically average only between 30-35%. Although this is a marked improvement over the virtually 0% generally found in the pretests, it is obvious that additional training sessions are necessary to bring the average soldier's skills up to an acceptable level. Interviews with soldiers who completed the CVI training suggested that the problem on the final test stemmed from confusions among similar vehicles which appeared in different modules. An analysis of the responses to the final test supplied hard evidence for this contention. There were several vehicles which were confused with each other with great frequency, but almost never confused with others. It was hypothesized, therefore, that a small amount of additional training to help soldiers distinguish between the most frequently confused sets of vehicles would improve performance substantially. This would be accomplished by presenting vehicles in pairs for comparison purposes. The simularities and differences would be focused on, and repetitions continued until the vehicles could be identified.

An opportunity to conduct a partial test (Kubala & Shope, 98) [131] of this hypothesis presented itself at Fort Stewart, Georgia. One group received an additional class period of CVI training in which slides of the most frequently confused vehicles were presented in pairs, with the primary differences between the vehicles being pointed out by the instructor. They were readministered the final test. The second group received no additional training but did take the final test again. The group receiving the additional training exhibited a 56% improvement in performance while the second group showed only a 7% improvement on the second test. It was concluded that these preliminary findings should be validated with larger groups, and also, that research needed to be conducted to determine if such gains were retained over time.

Accelerated Training Methodologies for R&I

There is a real need to discover ways by which R&I training time can be reduced without lessening the standards demanded by increased technology and the rapidly changing faces of battle. One of the most visible examples of accelerated (speed) learning were the much heralded "speed reading" courses. In just a few days one could be reading and comprehending vast quantities of written material. It is standard practice in many types of learning situations to gradually decrease the response time allowed. The CVI training format is an example of this "forced learning." Limiting exposure time for visual stimuli "compressed-time learning" is another example of speed learning. The use of accelerated learning methods and techniques as applied to perceptual learning may provide the solution whereby available training time can be put to more profitable use.

The Effect of Motivation on Success in Vehicle Identification Training

Extremely wide variation in individual learning rates has been observed in research on combat vehicle R&I training. Attempts to account for this have met with but minimal success. Basic aptitude (as measured by GT score), knowledge of nomenclature of vehicle parts, and some demographic variables all are related to learning rate, but even in combination do not account for the wide individual differences. Some soldiers achieve an acceptable level of performance after only two repetitions of training while others fail to achieve the same level after six repetitions. This variation creates a major training problem for commanders. Commanders must either spend considerably more time training some personnel, or, assign the slow learners to jobs where R&I skills are less imperative. Neither alternative is desirable. Research is needed first to determine why learning rates are so variable, and secondly, to seek a means of overcoming the problem when a cause or causes have been identified.

At present, it is not known whether the widely variable learning rates observed were a function of differences in basic aptitudes for perceptual training, or a function of other factors. Discussions with soldiers during breaks and before and after training sessions have led the research staff to hypothesize that motivational factors have played a significant role. However, no scientific evidence to support this hypothesis is currently available. Some previous work at the U.S. Army Air Defense School has provided good evidence that motivation for a particular endeavor is important and can be reliably measured. A peer rating of "desire to succeed in training" and a self-assessment questionnaire designed to assess motivation both proved to be valid predictors of success in electronics training. In many groups these measures had higher validities than the EL Area (Electronics) Aptitude composite score taken from the ASVAB which was used in selection for the training.[a]

If motivational factors prove to be unimportant, commanders can be so informed, and can then make realistic decisions concerning job assignments and/or the amount of time they want to program for vehicle identification training. There is very good evidence to show that scores on the first final test are highly predictive of the course of training. In other words, after one repetition a commander would know which of his personnel are likely to require extensive training to achieve an acceptable level, and can make plans either to provide this training or can consider assigning personnel with a poor prognosis to jobs where vehicle identification is less critical. In any case, the commander would know the extent of the problem and could realistically evaluate his options.

Research is needed to determine the exact extent of the role played by motivation in developing R&I skills. If motivational factors prove to be significant in training success, means of improving motivation can be sought. Some potential motivators should be examined as a part of this effort.

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[a] Personal communication with Dr. Albert Kubala, former chief of the Human Resources Research Office (HumRRO) field unit, Air Defense School, Fort Bliss, Texas.

Development of Simulated Imagery for an Improved Vehicle Thermal Recognition and Identification Training Program

Although through-the-sight imagery of more vehicles is being made available, it will still be necessary to employ simulation techniques in developing improved thermal R&I programs. This is because comparable imagery of all the required target array vehicles, especially the new Warsaw Pact vehicles, will not be available. Unless the imagery for all vehicles is comparable in terms of background and range, soldiers will learn to respond in training on the basis of irrelevant characteristics of the imagery. Therefore, techniques for depicting important thermal cues realistically through simulation are needed. Shape should still be stressed as the primary cue, but when it is possible for soldiers to obtain additional information, such as engine location or the number of roadwheels, these items can and should be employed and should be included in the training.

The thermal simulation approach currently being worked on by PM TRADE and discussed previously holds considerable promise and development should be continued, but at present it requires high resolution thermal imagery as a starting point. Unless a means of simulating the high resolution imagery can be developed, any program developed will necessarily be limited to those vehicles for which imagery can be obtained. Therefore, other approaches to simulation should continue to be developed to insure that realistic imagery at a reasonable cost will be available for training.

Specialized Training in Recognition and Identification

The Field Artillery School, Fort Sill, Oklahoma, approached the TAATS research team to assist them in the development of a training program for operators of the Remotely Piloted Vehicle (RPV). At that time they were considering a target array of over 300 targets. Members of the intelligence community met with the research team to discuss R&I training, and the number of targets in their projective array was extensive. At one time the Air Force approached the research team with a request for a program to aid pilots in recognizing and identifying threat formations, so that the critical vehicles in a target array could be attacked first. The TAATS team concentrated on individual ground vehicles. Little research has been accomplished on the learning of R&I skills for target arrays and man-made targets such as field installations, etc.

One commander of III Corps at Fort Hood advocated the use of specialized R&I personnel that would do the identifying for combat units. All soldiers would be trained to recognize and identify a limited number of vehicles. The specialists would be able to identify virtually all vehicles expected to be encountered in the theatre assigned. This approach would reduce the amount of training time for the majority of soldiers and make the training more productive. However, research is needed to determine the overall effectiveness of this approach, and to answer questions such as "what will be the effect on unit performance if the specialist becomes a casualty?"

Ground-to-Air, Air-to-Ground, and Air-to-Air Recognition and Identification

The research team received many inquiries concerning possible participation in research and development activities in these areas. This attests to the recognized requirements for R&I skills throughout the Army. Unfortunately, the manpower and funding were simply not available for the team to venture beyond the areas described in the previous sections. However, one mission of the Army's R&I proponent at Fort Leavenworth is that of coordinating Army-wide efforts in R&I research and development, and advising on funding priorities. Efforts in all of the aforementioned areas should be pursued if and when funding becomes available.

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